Wahler Associates
Geotechnical and Water Resources Engineering

GEOTECHNICAL INVESTIGATION

LEROY ANDERSON DAM
SPILLWAY ENLARGEMENT

SANTA CLARA VALLEY WATER DISTRICT

TA 705.3A56L4 1984

Geotechnical Investigation

LEROY ANDERSON DAM
SPILLWAY ENLARGEMENT

SANTA CLARA VALLEY WATER DISTRICT

February 1984

WAHLER ASSOCIATES

Geotechnical Engineers

Project SCV-124A

Wahler Associates
Geotechnical and Water Resources Engineering

February 24, 1984
Project SCV-124A

Mr. David K. Gill
Water Supply Manager
Santa Clara Valley Water District
5750 Almaden Expressway
San Jose, CA 95118

Subject: Report on Geotechnical Investigation--
Leroy Anderson Dam Spillway Enlargement

Dear Mr. Gill:

We are submitting herewith our report entitled "Geotechnical Investigation - Leroy Anderson Dam Spillway Enlargement". The investigation reported herein was carried out under the terms of Agreement No. A0591, approved by the District's Board of Directors on June 14, 1983.

The basic purpose of this investigation was to provide the District with the geotechnical information needed to prepare plans and specifications for construction to enlarge the spillway and modify the dam. The investigation concludes that, from a geotechnical standpoint, modifications can be made as proposed for either of the two basic alternatives currently being considered by the District. It appears geotechnically feasible to incorporate portions of the existing spillway structure and underdrain system into an enlarged spillway scheme.

We appreciate having had the opportunity to provide these services. If we can be of further assistance, please do not hesitate to contact us.

Very truly yours,

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EXECUTIVE SUMMARY

The Santa Clara Valley Water District plans to modify the spillway at Leroy Anderson Dam to accommodate a Probable Maximum Flood that is larger than the flood for which the facility was originally designed. The Water District's staff is designing the project modifications.

Two basic alternatives are being considered. One scheme would involve increasing the lined channel width from its existing 50 feet to a minimum of 105 feet, and constructing a new uncontrolled overflow section with a crest length of 210 feet, maintaining the spillway crest elevation at 625 feet. The existing dam would be raised slightly and a 3-foot-high floodwall would be added on the new crest of the dam. The other scheme would involve increasing the lined channel width to 128 feet and providing a 192-foot-long gated spillway crest, with the crest at an elevation of 620 feet and top of gates at Elevation 626.5 feet. In this scheme, the existing dam would be raised very slightly, but no floodwall would be necessary.

An extensive geotechnical investigation was performed to confirm there are no conditions that would preclude the proposed modifications, and to provide the data and geotechnical criteria for design. The field investigation included detailed geologic mapping, seismic refraction surveys, and numerous exploratory trenches, test pits and borings.

The investigation concludes that, from a geotechnical standpoint, the modifications can be made as proposed for either scheme. It appears geotechnically feasible to incorporate portions of the existing spillway structure and underdrain system into an enlarged spillway scheme.

The report on the geotechnical investigation contains numerous detailed conclusions, recommendations and geotechnical criteria for consideration in design of the project modifications. This Executive Summary presents a broad overview of site conditions, and the major conclusions and recommendations resulting from the investigation.

GEOLOGY AND SEISMICITY

The project is situated in the southwesterly portion of the Diablo Range, which comprises the eastern portion of the Coast Range geomorphic province. In the area of the project, the Diablo Range consists of a more or less central core of the Jurassic-Cretaceous Franciscan complex flanked by primarily sedimentary Cretaceous to Tertiary formations. Serpentine masses intrude the Franciscan complex and comprise much of the ridge forming the abutments for the dam. Late Tertiary to Pleistocene alluvial deposits overlie extensive portions of the older rocks, particularly along the middle and lower slopes of ridges in the project vicinity.

Franciscan complex rocks (including graywacke, greenstone and shale) and serpentine comprise the bedrock units underlying the spillway area. Surficial deposits include alluvium, fill, slopewash, and terrace deposit. Exploratory data indicate that the overflow section, chute floor slabs, and wall footings will be founded on either Franciscan complex or terrace deposit. Cut slopes will be in Franciscan complex, serpentine, fill, slopewash and terrace deposits.

The geologic investigation of the proximate spillway area suggests that there are no deep seated, active landslides in the slope above the spillway channel.

The project is located in a seismically active region which has been subjected to several strong earthquakes. The major active faults which are potential sources of strongest shaking at the site are the Calaveras, San Andreas and Hayward faults. The main characteristics of these faults, as they relate to the site, are given in the following table.

Fault	Distance From Site	Maximum Credible Earthquake (Richter Magnitude)	Expected Peak Acceleration (Percent of Gravity)
Calaveras	1 mile	7.5	70
San Andreas	12.5 miles	8.5	47
Hayward	9 miles	7.5	42

Although earthquakes on each of these faults could produce very strong motions at the site, it is possible to design the structures to withstand earthquake shaking. None of the above faults pass through the dam or spillway site, so they do not pose a threat in terms of ground rupture.

There is one other fault of particular interest in regard to the project. The Coyote Creek fault, which passes through the site, extends about 14 miles northwest toward the town of Coyote from its truncation by a series of high-angle faults about 8 miles southeast of the dam. Traces of this fault have been projected through the project site by a number of investigators. During the present investigation, clear evidence for a trace of the Coyote Creek fault was found only in the spillway approach channel area. A differently oriented fault zone of similar age was found in the open discharge channel. From geomorphic and soil-stratigraphic reconnaissance, it is concluded that last displacement of these fault segments took place at least 100,000 years ago, and conceivably well before that time. In view of the age of last movement on these faults, the likelihood of movement on these traces must be considered nil.

FOUNDATION CONDITIONS

With proper attention to design details and foundation treatment, the Franciscan complex bedrock units and terrace deposits encountered will provide adequate foundations for the various portions of the spillway.

The proposed overflow control structure will be founded on crushed and sheared serpentine. The existing spillway control structure is founded on the same material and does not show any foundation-related distress. The serpentine should be removable by common excavation---no blasting is anticipated.

The lined channel will be founded on serpentine for about 20 percent of the alignment, on terrace deposit for about 30 percent of the alignment, and on graywacke, with some shale, for about 50 percent. The same units underlie the existing lined spillway, which has held up well. Light blasting could be required in some portions of the graywacke, but most of the excavation will not require blasting.

Beyond the lower end of the lined spillway, the open discharge channel will be across Franciscan rock except for a reach near the lower end, where the channel would cross terrace deposit. Blasting will be required for excavation along portions of the channel in hard bedrock. Erosion protection will be required in selected areas along this open discharge channel---the extent depending on the amount of widening of the existing channel.

There is a direct correlation of reservoir surface elevation to the zone, elevation and quantity of seepage in the proposed spillway enlargement area. To simplify conditions in the excavation for the proposed overflow control structure, and to reduce seepage to reasonably manageable quantities during construction, it is recommended that the reservoir level be held to a maximum elevation of 610 feet during the construction period. After completion of the modifications, seepage will continue to occur in the spillway area and could be quite significant at high reservoir elevation. However, this seepage can be reasonably controlled by inclusion of an appropriate drainage system.

CONSTRUCTION MATERIALS

Sufficient earth materials of adequate quality to construct the proposed dam and dike raise can be obtained from the proposed excavations for either alternative spillway enlargement. Therefore, no new unsightly borrow areas will have to be developed to produce earthfill material for construction. In fact, preliminary estimates indicate there will be much more material available from excavation than will be needed for dam fill and random backfill. Thus, it will probably be necessary to spoil significant quantities in one or more selected areas where the material can be blended to the existing topography.

The District's botanical consultant worked closely with us in the field and identified specimens of Ceanothus ferrisea, an endangered plant species found at the site and which preferentially grows on serpentine-derived soils. Some of our test pits were excavated into fill derived from serpentine, and we observed that this fill also supports the growth of C. ferrisea. The planned spillway excavation will, in places, involve the removal of serpentine. The excavation will generate a considerably larger volume of material, including serpentine, than would be required for dam construction or structure backfill. The District may wish to investigate the botanical feasibility of using some of the excavated serpentine waste as fills which might provide an environment that would support continued growth of this plant species.

The fetch of reservoir, over which it is possible to generate waves that would impact on the dam, is relatively short. In addition, only on extremely rare occasions (if ever) will the upstream face of the proposed dam raise be exposed to wave action. Therefore, rock riprap slope protection on the upstream face of the dam need not be very large. A product having an average rock size of about 6 to 8 inches, with smaller and larger sizes reasonably well distributed through the mass, would be adequate. This rock could be obtained from offsite commercial sources or, alternatively, from the hard greenstone in the vicinity of the steep bluff at the lower end of the open discharge channel. That greenstone would have to be blasted.

DAM MODIFICATIONS

Raising the existing dam will be a relatively simple matter. The planned addition will be made directly on the crest of the existing dam by excavating back into the existing fill to obtain a suitable bond, and then constructing new fill having slightly steepened outer slopes. Soil material to be excavated in the process of widening the spillway can be used to construct the entire addition, except for slope protection. Material which, after compaction, would be sufficiently impermeable and strong to sustain the reservoir loading near the crest has been identified in the planned spillway expansion area.

One of the alternative schemes includes a concrete floodwall extending 3 feet above the modified crest of the dam. This floodwall would be founded within the new dam fill. The wall would be subjected to a very low water head if the Probable Maximum Flood were ever experienced. From a geotechnical standpoint, the proposed floodwall does not present any particular problems. Only very minor differential movements would be anticipated, and conventional waterstops at joints should be adequate.

INTRODUCTION

CHAPTER I

INTRODUCTION

A. GENERAL

This report presents the results of Wahler Associates' geotechnical investigation to support design of the proposed enlargement of Leroy Anderson Dam spillway and related work. This facility, part of the Santa Clara Valley Water District's system, is located in Santa Clara County, California, about three miles north of Morgan Hill and eleven miles southeast of San Jose.

The Santa Clara Valley Water District will design the project modifications, but at present the basic design and details are still to be resolved. The proposed modifications have been narrowed by the District to two basic alternatives (see Figures VII-1 and VII-2, in Chapter VII). These alternatives are:

- Alternative 2 - involves increasing the lined channel width from 50 feet to a minimum of 105 feet, constructing an uncontrolled ogee spillway with a crest length of 210 feet and maintaining the existing spillway crest elevation at 625 feet. This alternative also requires raising the dam to Elevation 642.5 feet from its present elevations of 637.5 to 640.0 feet and providing a floodwall to Elevation 645.5 feet. The top of the concrete channel lining (sidewalls) would be about 3.5 feet higher than the existing concrete lining.

- Alternative 4 - involves increasing the lined channel width from 50 feet to 128 feet and providing a 192-foot-long gated spillway, with an ogee crest elevation of 620 feet and top of gates at Elevation 626.5 feet. This alternative also requires raising the dam to Elevation 641.0 feet from its present elevations of 637.5 to 640.0 feet. Along the majority of the channel, the top of the concrete lining (sidewalls) would be about 1.5 feet higher than the existing lining. In the remaining portions of the channel, the top of the lining would be about 3 to 4 feet higher or lower than the existing lining.

The geotechnical investigation was directed toward providing the information and criteria to support design of either of the above alternatives.

B. AUTHORIZATION

The investigation described in this report was conducted under the terms of Agreement No. A0591, dated June 15, 1983, between the Santa Clara Valley Water District and Wahler Associates.

C. PURPOSE AND SCOPE

The basic purpose of the investigation was to provide the District with the geotechnical information needed to prepare plans and specifications for construction to enlarge the spillway and modify the dam. Specifically, the scope of our work included the following:

1. Review and evaluation of pertinent background and reference data, including: the District's and the the State of California Division of Safety of Dams files; published geologic reports and maps covering the project area; and other unpublished geologic data.

2. A field investigation program consisting of: detailed geologic mapping and airphoto interpretation; shallow seismic refraction surveys; backhoe trenching, testpitting, and sampling; exploration hole drilling and sampling in the area of the proposed spillway enlargement and on the crest of the dam; conversion of selected drill holes to observation wells; and periodic monitoring of these wells and of seepage from weep holes in the existing spillway.

3. Laboratory testing of bulk and undisturbed samples, to determine the basic index properties of materials to be excavated during enlargement of the spillway, and to estimate the engineering properties of soil-like foundation and cutslope materials.

4. Geologic and engineering analyses were conducted to formulate conclusions, recommendations and geotechnical design criteria.

5. The results of field work, laboratory testing, and geologic and engineering evaluations were periodically reviewed with representatives of the District, and our findings were orally presented to the State of California Division of Safety of Dams.

6. This report was prepared, describing all work done, incorporating the results of our analyses and the backup field and laboratory data, and presenting our conclusions and recommendations.

D. ORGANIZATION OF REPORT

This report is composed of the main text and three appendices. The text includes this Introduction and seven other chapters covering the regional geologic and seismic setting, site geology, foundation conditions, seepage conditions, construction materials, engineering analyses, and conclusions and recommendations. The appendices present field exploration data (Appendix A), laboratory test data (Appendix B), and a report entitled "Age of Faulting, Anderson Dam and Spillway Geotechnical Investigations, Santa Clara County, California" (dated August 3, 1983), by Dr. Roy J. Shlemon.

E. LIMITATIONS

The data, information, interpretations, and recommendations in this report are presented specifically and solely as bases and guides for the design of the proposed project. The conclusions and professional opinions presented herein were developed by Wahler Associates, in accordance with generally accepted geotechnical engineering principles and practices. Wahler Associates cannot be responsible for any conclusions or recommendations that may be made by others, unless we have been given an opportunity to review such conclusions and concur in writing.

This report has not been prepared for use by parties other than the Santa Clara Valley Water District. It may not contain sufficient information for the purposes of other parties or other uses. If any changes are made in the project as described in this report, the conclusions and recommendations contained herein should not be considered valid unless the changes are reviewed by Wahler Associates, and the conclusions and recommendations of this report are modified or approved in writing. This report and the drawings contained herein are intended for evaluation and design purposes only. They are not intended for construction.

The analyses that we have made assume that the data determined in the field and laboratory are reasonably representative of field conditions and that the subsurface conditions are reasonably susceptible to interpolation and extrapolation from locations of subsurface exploration. However, site conditions may vary in detail, and the processes of exploration and design must be considered to continue during construction. It is extremely important that, if conditions are encountered during construction which vary significantly from those assumed in the design, they immediately be brought to the attention of the designers so that they can be evaluated and the necessary recommendations or design changes can be made. To confirm that site conditions are in substantial conformance with the assumptions made in the design or, if they are not, to provide the opportunity for the necessary adjustments to be made in an expeditious and responsive manner, it is also essential that the information and data developed during construction be reviewed on a regular and routine basis by the designers.

F. PERFORMANCE

For Wahler Associates, Charles W. Perry served as project manager. Antonio S. Buangan directed and reviewed the geologic studies, and Ernest Solomon was project geologist. John J. Heneghan was project engineer, and was assisted in the geotechnical engineering analyses and evaluations by Jose I. Landazuri. Mr. Perry and Jack G. Wulff exercised review of the work and provided consultation on the project.

G. ACKNOWLEDGEMENTS

Wahler Associates is grateful to the management and staff of the Santa Clara Valley Water District, particularly Messrs. Edwin Ferguson, Robert Tepel, Thomas Dean and Gary Kawaoka, for their cooperation and guidance and for providing pertinent information used in this report.

REGIONAL GEOLOGIC
AND
SEISMIC SETTING

CHAPTER II

REGIONAL GEOLOGIC AND SEISMIC SETTING

A. REGIONAL GEOLOGY

Anderson Dam and Spillway are in the southwesterly portion of the Diablo Range. The range comprises the eastern portion of the Coast Range geomorphic province and consists of a series of northwest-trending ridges which separate the trough encompassing San Francisco Bay and the Santa Clara Valley from the San Joaquin Valley. The dam is located on Coyote Creek, which drains the range and breaches a ridge overlooking the Santa Clara Valley. The spillway is located in a saddle at the head of a small west draining valley in that ridge. The regional geology is depicted on Figure II-1.

Complexly folded and faulted Tertiary marine and non-marine formations, Cretaceous marine formations, serpentine, basic igneous dikes, and Franciscan complex comprise the Diablo Range extending eastward from the valley floor below the site. Late Tertiary to Quaternary alluvial, colluvial, and lacustrine deposits occur along the western slope of the range.

Near the study area, the Diablo Range consists of a more or less central core of the Jurassic-Cretaceous Franciscan complex flanked by primarily sedimentary Cretaceous to Tertiary formations. Tabular serpentine masses intrude the Franciscan complex and comprise much of the ridge forming the abutments for the dam. Intrusive and extrusive igneous rocks of more limited extent occur. Late Tertiary to Pleistocene alluvial deposits overlie extensive portions of the older rocks, particularly along the middle and lower slopes of ridges near the study area as shown on Figure II-2.

B. SEISMICITY

The project area is located in a seismically active region which has been subjected to several strong earthquakes during historic time. In the San Francisco Bay region, the history of earthquakes that probably affected the Anderson Dam area goes back to the early 1800's. Earthquakes have occurred throughout the entire San Francisco Bay region, but most of them have been concentrated along the San Andreas, Hayward, and Calaveras fault zones. Figure II-3 shows the distribution of magnitude 4.0 and greater earthquakes in the San Francisco Bay region.

Four or five earthquakes of magnitude 7 or greater are thought to have occurred in this region since 1800. Of these, the 1906 San Francisco earthquake, which occurred on the San Andreas fault, has been assigned a magnitude 8¼ (Gutenberg and Richter, 1949). The large June 1838 earthquake produced effects similar to those of the 1906 event, breaking the ground surface along the San Andreas fault between San Francisco and Santa Clara County and probably had nearly an equivalent magnitude. The great Hayward fault earthquakes of 1836 and 1868 produced effects approximately equivalent to magnitude 7 or greater.

Between 1900 and January, 1980 (Figure II-3), 12 earthquakes of magnitude 4.0 or greater occurred within a 10-mile radius of the site including two significant events on the Calaveras fault, which passes within one-mile of the site. The epicenter of the August 6, 1979, magnitude 5.7 Coyote Lake earthquake was determined to be less than one-mile east of the Calaveras fault, about 10 miles southeast of the site. The June 1, 1911 earthquake, with an estimated magnitude of 6.6, is thought to have occurred on the Calaveras fault east of Coyote about 8 miles northwest of the site. Modified Mercalli intensities for this event ranged from VII to IX at Coyote and from VII to VIII at San Jose, Morgan Hill, and Gilroy.

Plots of epicenters of recent, small earthquakes show a spatial distribution similar to that of the larger earthquakes. Figure II-4 (Brown and Lee,

1971) shows locations of active faults and the epicenters of earthquakes greater than magnitude 0.5 for the period January 1, 1969, to December 31, 1970. Most epicenter locations are within a mile or so of known fault traces. Seismic activity on the Calaveras fault for the two-year period is well defined for a segment of the fault extending from a point about six miles south of Hollister to a point about five miles east of Fremont. A concentrated line of seismic activity is apparent in the San Andreas fault west of Gilroy and the San Juan Bautista area.

C. FAULTING

The major active faults in the Anderson Dam spillway area are the Calaveras, which is approximately one-mile east of the dam, the San Andreas, approximately 12.5 miles southwest, and the Hayward, about 9 miles northwest of the site. Each of these three faults is associated with historic, large magnitude, destructive earthquakes and is a potential source of strong shaking at the site.

Two smaller faults have been mapped in the vicinity of the site and have been considered to be potentially active. These faults are the Coyote Creek fault, which has been mapped at the site (Dibblee, 1973a, 1973b), (Wagner 1978), and the Silver Creek fault, 0.7-mile northwest of the site (Rogers and Williams, 1974, Wagner, 1978).

1. Calaveras Fault

The Calaveras fault zone consists of several subparallel faults which pass about one-mile east of Anderson Dam (Ibid.). Opposite the dam, the zone is almost 0.5-mile wide. The fault, which is approximately 90 miles long, is considered to have been the source of the July 3, 1861 magnitude 6½ (estimated) earthquake with ground rupture in the San Ramon and Amador valleys. It is considered capable of generating a magnitude 7.5 earthquake with a right-lateral displacement of 10 to 16 feet (W.A. Wahler and Associates and others, 1977).

2. San Andreas Fault

The San Andreas fault zone, which passes approximately 12.5 miles southwest of the site, has an approximate total length of 700 miles and is considered capable of generating a magnitude 8.5 earthquake (Ibid.). The magnitude 8¼ San Francisco earthquake in 1906 resulted from movement on the San Andreas fault.

3. Hayward Fault

The Hayward fault, which trends northwesterly from its southernmost delineation about 9 miles northwest of the site, has a total length of about 100 miles and is considered capable of generating a magnitude 7.5 earthquake. The October 21, 1868, magnitude 7+ (estimated) earthquake, which caused 3 feet of horizontal offset and had a total rupture length of 20 miles, has been assigned to the Hayward fault.

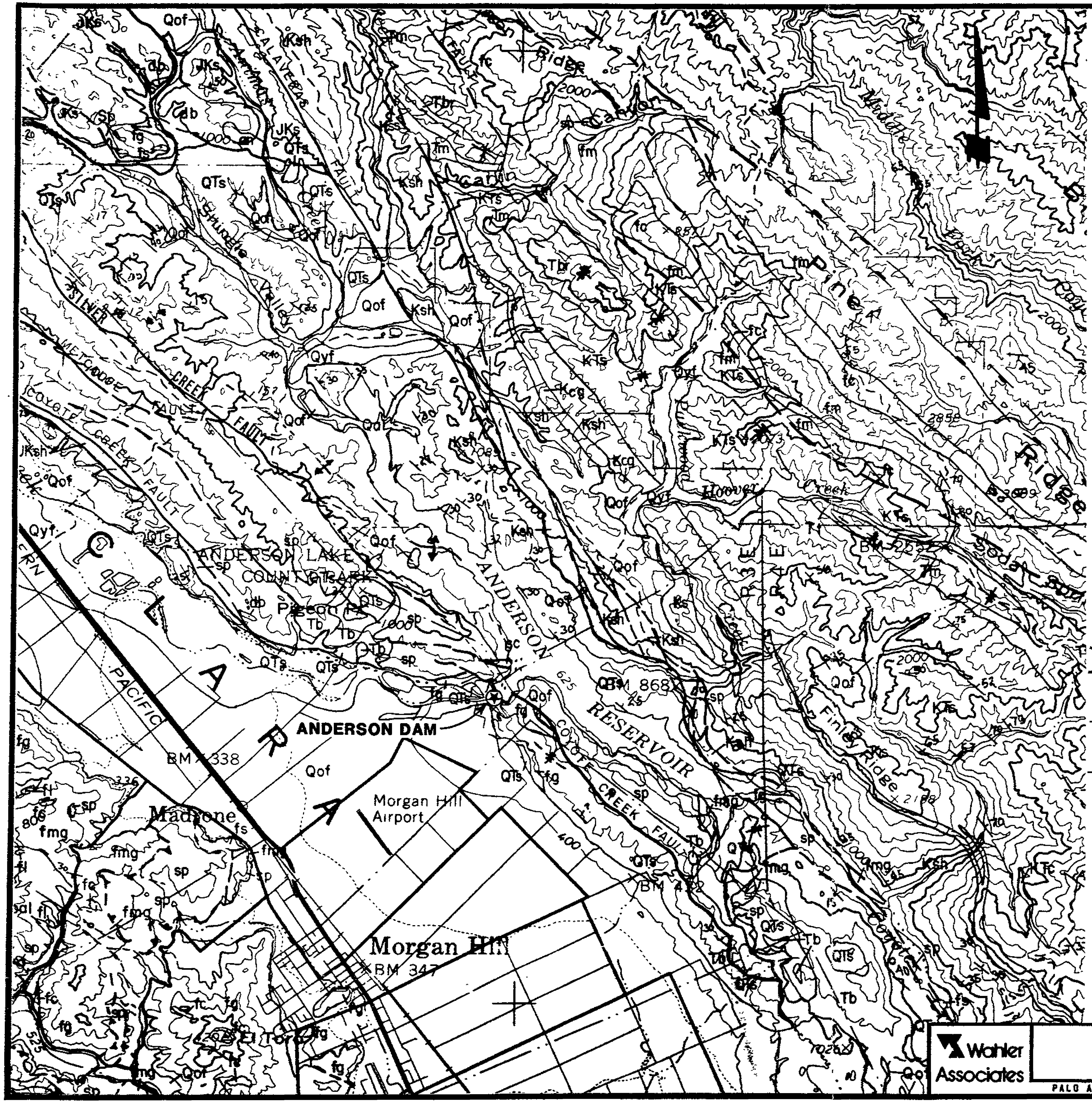
4. Coyote Creek Fault

The Coyote Creek fault (also referred to as the Coyote Thrust fault) trends along the northeastern foothill area of upper Santa Clara Valley. The fault extends about 14 miles northwest toward the town of Coyote (Rogers and Williams, 1974) from its truncation by a series of high-angle faults associated with the Calaveras and Silver Creek fault zones about 8 miles southeast of Anderson Dam (Wagner, 1978). Because the Coyote Creek fault passes through the site, it is discussed in more detail in Chapter III.

5. Silver Creek Fault

The Silver Creek fault is a northwesterly-trending fault about one mile east of and parallel to the Coyote Creek fault. Wagner (1978) shows that the Silver Creek Fault branches off the Calaveras fault about 2½ miles southeast of Anderson Dam and passes beneath Anderson Reservoir east of the dam

(Figure II-5). The Silver Creek fault has been mapped for about 14 miles from its southernmost tip northwesterly towards south San Jose (Wagner, 1978, Rogers and Williams, 1974).



EXPLANATION

GEOLOGIC UNITS

QUATERNARY

Qal	STREAM ALLUVIUM
Qyf	YOUNG ALLUVIAL FAN
Qof	OLDER ALLUVIAL FAN
Qts	NON MARINE SEDIMENTARY ROCKS (INCLUDES SANTA CLARA AND PACKWOOD FORMATION)

TERTIARY

Tb	VOLCANIC ROCK
Tbr	BRIONES FORMATION: FOSSILIFEROUS SANDSTONE
Tm	MONTEREY FORMATION: SILICEOUS SHALE, CHERT, MUDSTONE

CRETACEOUS

KTs	HARD SANDSTONE, SHALE
KTc	HARD CONGLOMERATE
Ks	HARD SANDSTONE, SHALE
Ksh	HARD SANDSTONE, SHALE
Kcg	HARD SHALE, SOME SANDSTONE, LIMESTONE (INCLUDES BERRYESSA FORMATION)

FRANCISCAN COMPLEX

fs	SANDSTONE, SHALE
fmg	MELANGE
fg	GREENSTONE
fm	METAMORPHIC ROCK
fc	CHERT
sp	SERPENTINE
db	INGNEOUS ROCKS, GABBRO AND DIABASE

SYMBOLS

FAULT - SOLID WHERE WELL LOCATED, DASHED WHERE APPROXIMATELY LOCATED, DOTTED WHERE CONCEALED, QUERIED WHERE INFERRED, BARBS INDICATE THRUST FAULT (BARBS ON UPPER PLATE)

LITHOLOGIC CONTACT - SOLID WHERE WELL LOCATED, DASHED WHERE APPROXIMATELY LOCATED, DOTTED WHERE CONCEALED, QUERIED WHERE INFERRED.

CONTACT BETWEEN THE FRANCISCAN MELANGE AND THE OTHER FRANCISCAN UNITS, SOLID WHERE WELL LOCATED, DASHED WHERE APPROXIMATELY LOCATED, DOTTED WHERE CONCEALED, QUERIED WHERE INFERRED.

25 STRIKE AND DIP OF BEDDING, NUMBER INDICATES THE DEGREE OF DIP

ANTICLINE

SYNCLINE

LINEAMENT FROM AERIAL PHOTOGRAPHS

SOURCE: ROGERS & WILLIAMS, 1974

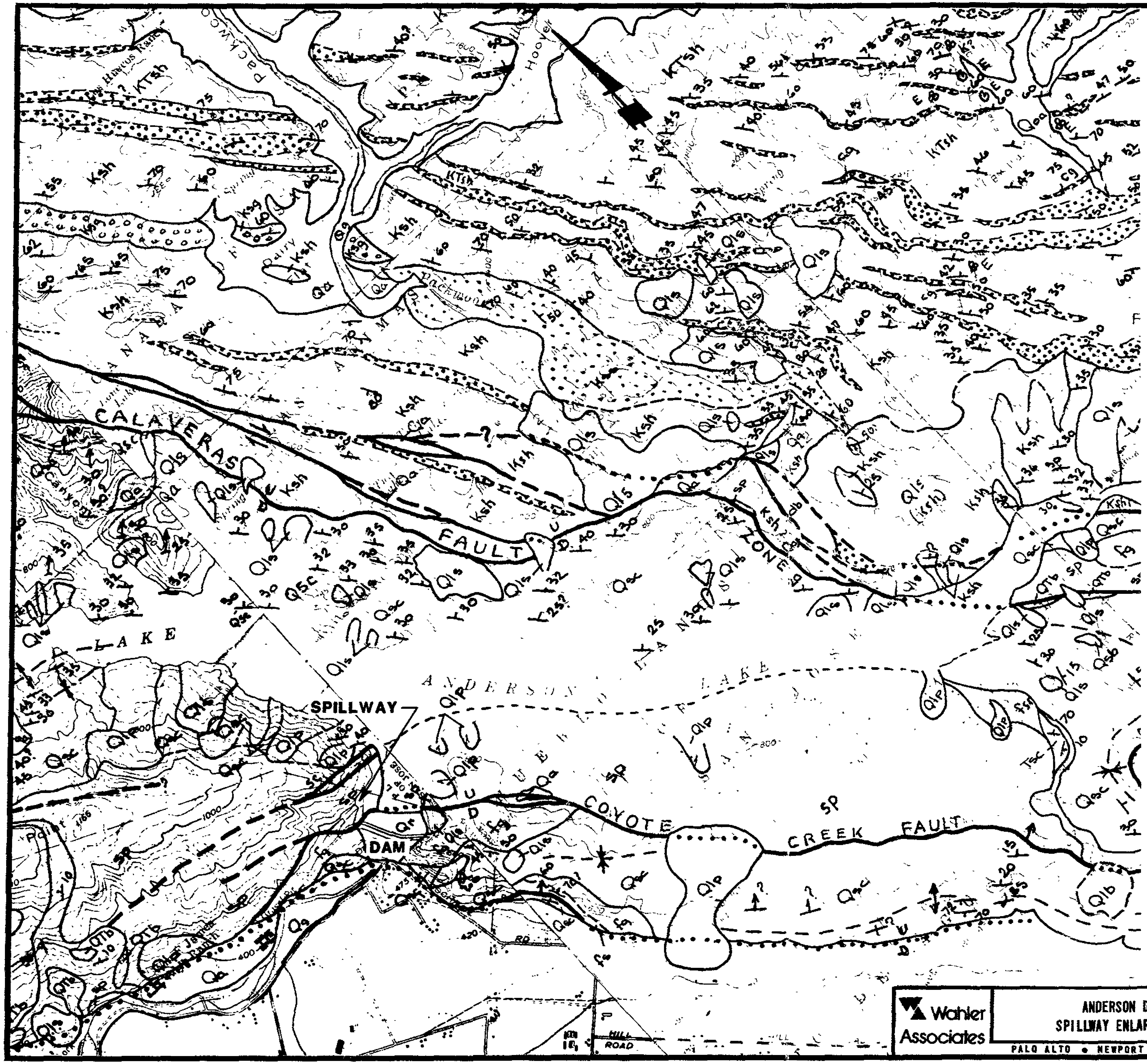
SCALE
3000 0 3000 FEET
SCALE 1:62,500

Wahler Associates
PALO ALTO • NEWPORT BEACH • CALIF.

ANDERSON DAM
SPILLWAY ENLARGEMENT

REGIONAL GEOLOGY

PROJECT NO.	DATE	FIGURE NO.
SCV-124A	DECEMBER 1983	II-1



GEOLOGIC UNITS

Qr	ARTIFICIAL FILL
Qg	STREAM GRAVEL, SAND
Qa	ALLUVIUM: GRAVEL, SAND, SILT, CLAY
Qls	LANDSLIDE DEBRIS
Qlp	LANDSLIDE OF SERPENTINE DEBRIS
Qlb	LANDSLIDE OF BASALT DEBRIS
Qoa	OLDER ALLUVIUM
Qsb	SANTA CLARA FORMATION: GRAVEL WITH BASALT DETRITUS
Qsc	SANTA CLARA FORMATION, GRAVEL, SAND, CLAY
QTb	PLIO – PLEISTOCENE BASALT (UNNAMED)
KTsh	MARINE SEDIMENTARY ROCKS (UNNAMED)
Ksh	BERRYESSA FORMATION (?), CLAY, SHALE
fg	FRANCISCAN COMPLEX, GRAYWACKE, GREENSTONE
sc	SILICA CARBONATE ROCK
sp	SERPENTINE
db	DIABASE

SYMBOLS

60	GEOLOGIC CONTACT, DIP
45	FAULT, WITH RELATIVE MOVEMENT, DIP
30	DIP AND STRIKE OF BEDDING
	ANTICLINE
	SYNCLINE
	CONGLOMERATE OF KTsh
	LANDSLIDE

SCALE

2000 0 2000 FEET

SOURCE: DIBBLEE (1973)
MORGAN HILL, MT. SIZER
QUADRANGLES

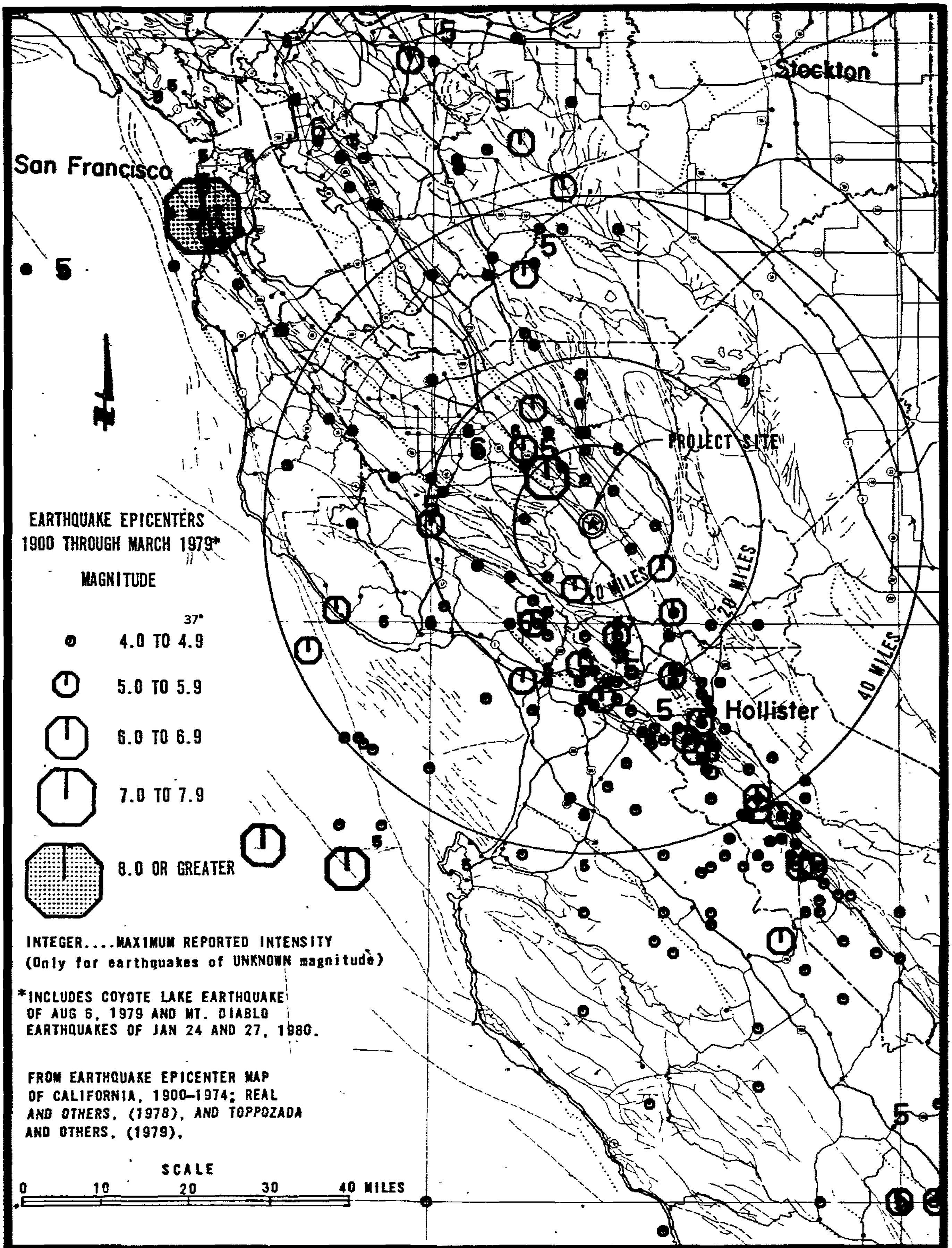
Wahler Associates

ANDERSON DAM
SPILLWAY ENLARGEMENT

PALO ALTO • NEWPORT BEACH • CALIF.

AREAL GEOLOGY

PROJECT NO.	DATE	FIGURE NO.
SCV-124A	DECEMBER 1983	II-2



EARTHQUAKE EPICENTERS
1900 THROUGH MARCH 1979*

MAGNITUDE

- 4.0 TO 4.9
- 5.0 TO 5.9
- 6.0 TO 6.9
- 7.0 TO 7.9
- 8.0 OR GREATER

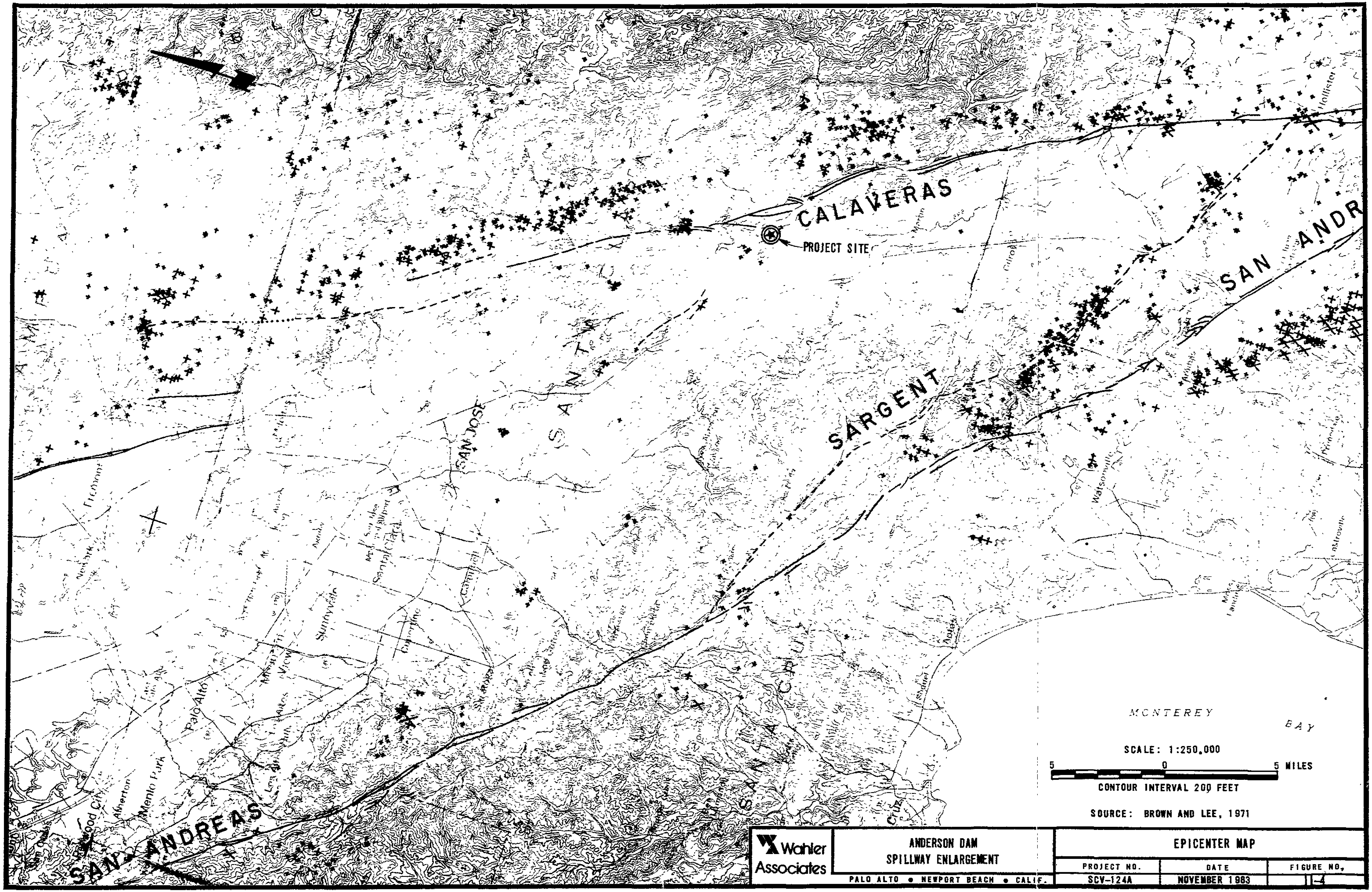
INTEGER....MAXIMUM REPORTED INTENSITY
(Only for earthquakes of UNKNOWN magnitude)

*INCLUDES COYOTE LAKE EARTHQUAKE
OF AUG 6, 1979 AND MT. DIABLO
EARTHQUAKES OF JAN 24 AND 27, 1980.

FROM EARTHQUAKE EPICENTER MAP
OF CALIFORNIA, 1900–1974; REAL
AND OTHERS, (1978), AND TOPPOZADA
AND OTHERS, (1979).

SCALE
0 10 20 30 40 MILES

Wahler Associates	ANDERSON DAM SPILLWAY ENLARGEMENT	SEISMICITY MAP SAN FRANCISCO BAY REGION		
		PROJECT NO.	DATE	FIGURE NO.
PALO ALTO • NEWPORT BEACH		SCV-124A	NOVEMBER 1983	II-3



CONTOUR INTERVAL 200 FEET

SOURCE: BROWN AND LEE, 1971

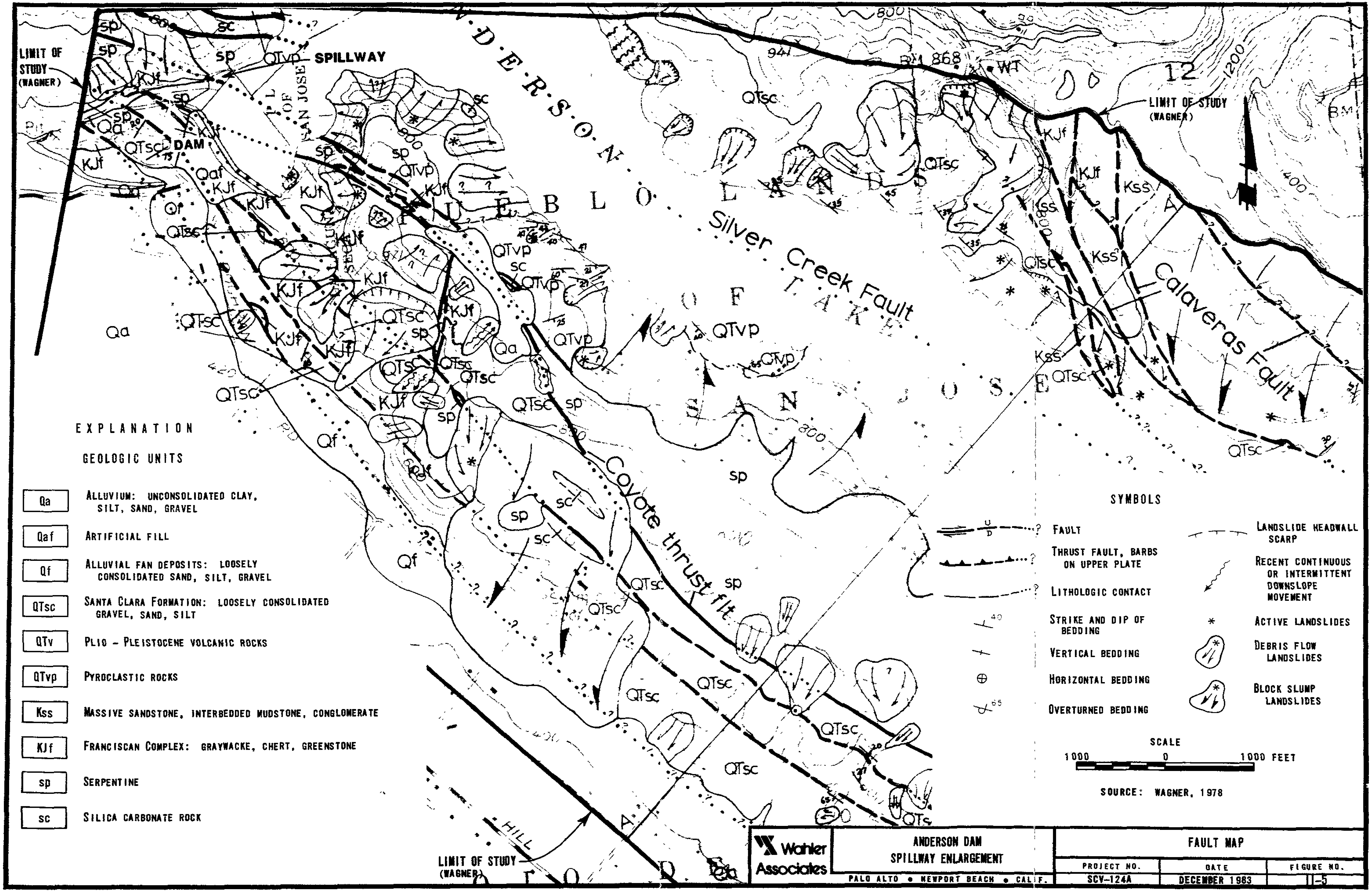
Wahler Associates

ANDERSON DAM
SPILLWAY ENLARGEMENT

PALO ALTO • NEWPORT BEACH • CALIF.

EPICENTER MAP

PROJECT NO.	DATE	FIGURE NO.
SCV-124A	NOVEMBER 1983	II-4



EXPLANATION

GEOLOGIC UNITS

Qa	ALLUVIUM: UNCONSOLIDATED CLAY, SILT, SAND, GRAVEL
Qaf	ARTIFICIAL FILL
Qf	ALLUVIAL FAN DEPOSITS: LOOSELY CONSOLIDATED SAND, SILT, GRAVEL
QTsc	SANTA CLARA FORMATION: LOOSELY CONSOLIDATED GRAVEL, SAND, SILT
QTv	PLIO - PLEISTOCENE VOLCANIC ROCKS
QTvp	PYROCLASTIC ROCKS
Kss	MASSIVE SANDSTONE, INTERBEDDED MUDSTONE, CONGLOMERATE
KJf	FRANCISCAN COMPLEX: GRAYWACKE, CHERT, GREENSTONE
sp	SERPENTINE
sc	SILICA CARBONATE ROCK

SYMBOLS

FAULT
THRUST FAULT, BARBS ON UPPER PLATE
LITHOLOGIC CONTACT
STRIKE AND DIP OF BEDDING
VERTICAL BEDDING
HORIZONTAL BEDDING
OVERTURNED BEDDING
LANDSLIDE HEADWALL SCARP
RECENT CONTINUOUS OR INTERMITTENT DOWNSLOPE MOVEMENT
* ACTIVE LANDSLIDES
DEBRIS FLOW LANDSLIDES
BLOCK SLUMP LANDSLIDES

SCALE
1000 0 1000 FEET

SOURCE: WAGNER, 1978

Wahler Associates
ANDERSON DAM
SPILLWAY ENLARGEMENT
PALO ALTO • NEWPORT BEACH • CALIF.

FAULT MAP

PROJECT NO.	DATE	FIGURE NO.
SCV-124A	DECEMBER 1983	II-5

SITE GEOLOGY

CHAPTER III
SITE GEOLOGY

A. GENERAL

The site geology described below is based primarily upon field exploration performed as part of this study. The field exploration consisted of geologic mapping, exploration hole drilling, backhoe trenching, and seismic refraction surveys. The site geology and the location of the exploration are shown on maps, Figure III-1 and Figure III-2, and Sections, Figures III-3 through III-11. Exploration hole logs, exploration trench and test pit logs, and the results of the seismic refraction surveys are included in Appendix A of this report. In addition, photogeologic review and review of pertinent reports, correspondence, geologic maps and sketches, and photos were performed.

B. BEDROCK UNITS

Franciscan complex and serpentine comprise the bedrock units underlying the spillway area. Franciscan rock types at the site include graywacke, greenstone, and shale. Neither limestone nor chert were observed. Both faulted and unfaulted contacts occur between the various rock units; in the open discharge channel where they are best exposed, the contacts trend northeast-southwest.

1. Graywacke

Graywacke is exposed along approximately 500 feet of the open discharge channel southwesterly of the plunge pool and in an irregularly shaped, but somewhat elongated area about 230 to 450 feet south of the lower end of the existing lined spillway channel. The latter area appears to have been exhumed by excavation of the overlying terrace deposit as a source of embankment material during construction of Anderson dam. Small (a very few square feet) pods of graywacke were mapped in the approach channel and along the dam egress road -- areas which were otherwise predominantly serpentine. Subsurface exploration indicates that a major portion of the remnant of the small valley along the south side of the lined channel is underlain by graywacke west of Station 6+60 (existing spillway channel station). No graywacke was observed along the cutslope on the north side of the lined channel.

Except for a prominent, hard, massive, cliff-forming exposure just beyond the northwest corner of the plunge pool and the weathered, but massive appearing "exhumed" exposure a few hundred feet south of the lower end of the lined channel, the graywacke does not appear to occur in extensive masses, but rather it appears to be "interbedded" with the shale and to a lesser extent, the greenstone and the serpentine. There may be an extensive graywacke unit underlying the small valley south of the lined spillway. Both faulted and unfaulted contacts were observed. The trend of the contacts, in those exposures along the discharge channel, is generally northeast-southwest.

The graywacke, which is characteristically gray to gray-brown where fresh, weathers to yellow-brown. Fresh, hard graywacke occurs along the discharge channel, and forms a prominent cliff northwest of the plunge pool.

2. Greenstone

Greenstone is exposed prominently at the lower end of the open discharge channel, where quarrying operations associated with dam construction have resulted in an extremely steep face almost 100 feet high. The greenstone forms a continuous exposure west of the egress road along the south side of the narrow ridge which borders the south side of the discharge channel. Relatively high seismic velocities in seismic line SL-10 suggest that the narrow ridge may also be underlain by greenstone. Greenstone also occurs as small pods and masses along the discharge channel.

The greenstone is a dusky-green to red-brown metavolcanic rock, which, in most of the exposures along the discharge channel is hard, strong, and little to moderately fractured. Crushed, sheared greenstone was encountered in trench T-21 about 280 feet south of the discharge channel.

3. Shale

Black to dark gray shale appears to generally be associated with the graywacke, but is of lesser extent. Both unfaulted and faulted contacts between the shale and the graywacke were observed. The shale occurs along the upper third of the open discharge channel (first 300 feet) and was encountered in borings AD-5 and AD-8, respectively 40 and 100 feet south of the end of the lined channel. The shale is faulted and crushed along its contact with the massive graywacke exposure northeast of the plunge pool and in an exposure along the bank of the open discharge southwest of the plunge pool.

The shale is typically intensely fractured to crushed and weak to soft. Where it has been crushed, the shale occurs as a clay which may have some hard shale fragments. The intensely fractured shale generally has clay filled fractures.

4. Serpentine

Serpentine comprises nearly all of the rock in the approach channel, and the upper portion of the ridge south of the spillway. The serpentine is exposed to a lesser extent in the cut above the right side of the existing spillway channel and in places along the open discharge channel. In addition, the serpentine was encountered in exploration holes and some of the exploration trenches in the dike and other fill areas and the upper end of the small valley south of the existing channel between Stations 3+50 and 5+50.

The serpentine is typically gray to blue-gray to gray-green, crushed and/or sheared, altered, and weak to soft. Much of the serpentine is intimately slickensided, and although it has a rock-like appearance, it is more soil-like in character, especially when wet. Some yellow to tan, oxidized and altered zones occur, as well as zones which contain hard, blocky, cobble-size pieces of serpentine. There were also very limited exposures of hard, blocky, closely to moderately fractured serpentine in the approach channel.

C. SURFICIAL DEPOSITS

Surficial deposits at the site include alluvium, fill, slopewash, and terrace deposit. The surficial occurrence of these deposits is shown on Figures III-1 and III-2.

1. Alluvium

A thin alluvial deposit has developed along the open discharge channel during the years since completion of the dam and spillway (really since first operation of the spillway). The alluvium is judged to be less than 5 feet thick and consists of gravel, cobbles, and boulders derived from the adjacent channel banks and cut slopes.

2. Fill

Two types of fill occur at the site. Clayey soils, apparently derived largely from excavation in terrace deposit, were used to construct the earthen dike which extends from the existing spillway retaining wall to the upper end of the ridge forming the right abutment for the dam. These soils were placed on serpentine and are as much as 24 feet thick at hole AD-1 (Figure III-3).

Silty and clayey sandy soils, apparently derived largely from excavations in serpentine and graywacke, were placed in certain areas on the ridge south of the lined spillway channel, on the downstream slopes of the earthen dike, and in certain areas on the south side of the open discharge channel. These soils are as much as 25 feet thick in hole AD-2, but are more commonly 5 to 15 feet thick in the areas investigated (Figures III-4 through Figure III-11). Fill derived largely from excavation in the graywacke appears to have been placed along the ridge south of the dam egress road approximately between Elevations 545 and 590. At least 12 feet of fill derived largely from excavation in graywacke was encountered in test pit TP-19. Small fillets of fill of undetermined origin were also placed along the walls of the lined channel. One characteristic of the fill derived from serpentine is that it, in addition to those soils developed in-situ on serpentine, supports the growth of Ceanothus ferrisae, an endangered species, whose restricted ecological niche includes the need for its roots to sustain themselves in soils derived from serpentine.

3. Slopewash

Slopewash occurs along the remnant of the small valley south of the lined channel, along oversteepened slopes, such as on the north side of the approach channel, above the north side of the lined channel, and in limited exposures along the open discharge channel (Figures III-1 and III-2). The slopewash deposits occurring along the oversteepened slopes are typically of limited extent, are relatively thin, and consist of red-brown, clayey sands with some gravel.

The slopewash occurring in the small valley extends the length of the valley (Figure III-8), overlies terrace deposit and Franciscan complex and is as much as 14 feet thick (AD-9). This valley fill colluvial deposit consists of very dark brown, dark red-brown, moderately to highly plastic fine-grained soils (clay and silt) which are moderately to highly expansive.

4. Terrace Deposit

Terrace deposit, considered to be a Pleistocene (Shlemon, 1983, Appendix C, this report) fluvial and interfluvial deposit, possibly correlative with Santa Clara formation, occurs widely at the site (Figure III-1 and Figure

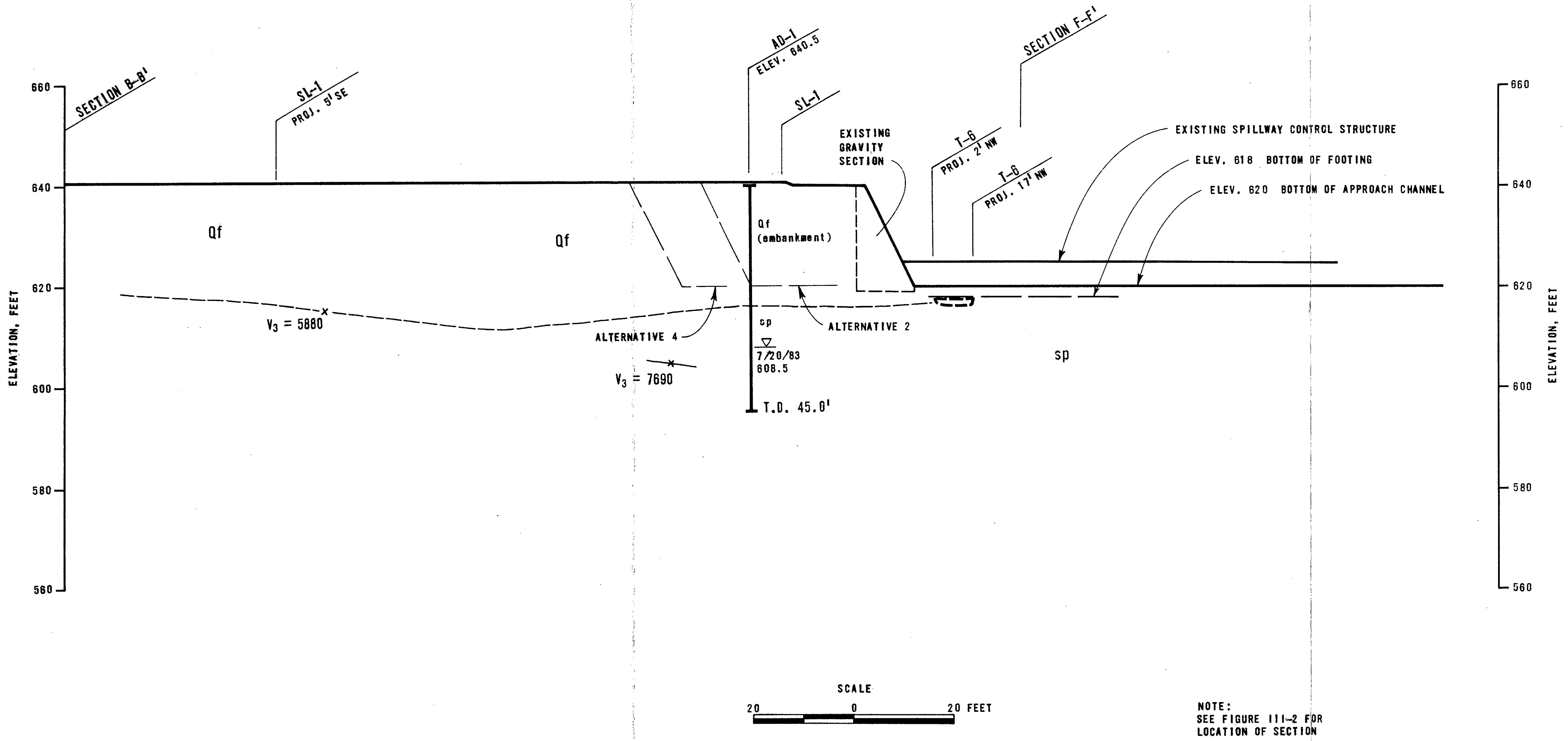
III-2). The extreme oxidation of the terrace deposit and its position, about 150 feet above the original stream grade, suggests an age of tens of thousands to over 100,000 years (Ibid.). The terrace deposit is exposed on the north side of the approach channel, on the north side of the lined channel, and on either side of the open discharge channel. An old landslide/mudflow, which occurs on the north side of the open discharge channel, is included in the terrace deposit (Location 8-1, Figure III-2). In addition, terrace deposit directly underlies a large portion of the fill and slopewash in the small valley south of the lined channel, possibly the fill south of the upper 300 feet of the open discharge channel, and a portion of the lined channel (Figure III-4 through Figure III-11). The terrace deposit overlies Franciscan complex and is as much as 23 feet thick (hole AD-3) south of the lined channel.

The terrace deposit consists of red-brown and dark red-brown clayey sand with minor lenses of gravelly clayey sand and a few lenses of gray to light brown, sandy gravel and gravelly sand. Cemented horizons occur low in the section in the approach channel.

D. FAULTING

Traces of the Coyote Creek fault have been projected through the project site by a number of investigators. Dibblee (1973, see Figure II-2, this report) delineated two traces of the Coyote Creek fault, one extending through the right abutment of the dam toward the lower end of the lined channel, and the second, along the toe of the dam northwesterly along the base of the foothills. Wagner (1978, see Figure II-5, this report), shows six traces of the "Coyote Thrust" fault encompassing an area about 1,700 feet wide at the site, with some of the traces delineating contacts between different rock types. The traces have a general northwesterly trend across the site.

Pleistocene movement is suggested by the fault contacts between Santa Clara formation (terrace deposit) and the Franciscan complex shown on Wagner's



NOTE:
SEE FIGURE III-2 FOR
LOCATION OF SECTION

EXPLANATION

GEOLOGIC UNITS
QUATERNARY DEPOSITS

Qf	FILL: SILTY SAND, CLAYEY SAND LARGELY DERIVED FROM SERPENTINE, SOME GRAYWACKE, EXCEPT EMBANKMENT; LIGHT TO DARK GRAY.
Qal	ALLUVIUM: SAND, GRAVEL, COBBLES
Qsw	SLOPEWASH: UNDIFFERENTIATED
Qsw_r	CLAYEY SAND, RED BROWN, LOCALIZED THIN DEPOSITS ON STEEP SLOPES
Qsw_b	CLAY, DARK BROWN-BLACK, ACCUMULATED IN GENTLY SLOPING LOW AREAS.
Qt	TERRACE DEPOSIT: COMMONLY CLAYEY SAND, SANDY CLAY, SOMETIMES GRAVELLY, UNDIFFERENTIATED OLDER COLLUVIAL AND ALLUVIAL DEPOSIT; OFTEN RED BROWN.
Qt_1	SANDY GRAVEL WITH COBBLES; FRANCISCAN DETRITUS; UNCEMENTED; OLDER ALLUVIUM; GRAY
Qt_2	CLAYEY SANDY GRAVEL WITH COBBLES, BOULDERS; FRANCISCAN DETRITUS; CEMENTED IN SOME HORIZONS, ESP. LOWER IN SECTION; OLDER ALLUVIUM AND COLLUVIUM; RED BROWN - DARK RED BROWN.

MESOZOIC DEPOSITS
FRANCISCAN COMPLEX

gw	GRAYWACKE: DARK GRAY TO GRAY, FRESH; TAN, WEATHERED; INTENSELY FRACTURED TO MASSIVE; FINE GRAINED; WELL CEMENTED; STRONG EXCEPT WHERE SHEARED OR WEATHERED.
gr	GREENSTONE: DUSKY GREEN TO RED BROWN; METAIGNEOUS ROCK; HARD, MODERATELY FRACTURED
sh	SHALE: DARK GRAY TO BLACK; DISCONTINOUS; COMMONLY SHEARED, CRUSHED.

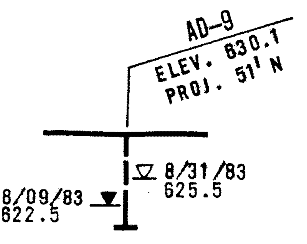
ULTRABASIC INTRUSIVE

sp	SERPENTINE: LIGHT TO DARK GREEN, SOME TAN OR YELLOW; COMMONLY CRUSHED AND/OR SHEARED, ALTERED.

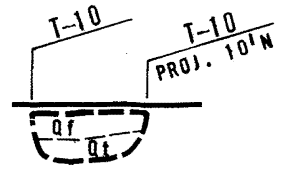
GEOLOGIC SYMBOLS

— — ? —	FAULT, DASHED WHERE INFERRED, QUERIED WHERE DOUBTFUL.
- - - — ? —	GEOLOGIC CONTACT, DASHED WHERE INFERRED, QUERIED WHERE DOUBTFUL.
▽ 8/31/83	WATER LEVEL, DATE
♀	SEEP
≋	SHEARED ROCK

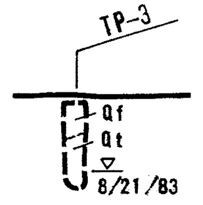
EXPLORATION SYMBOLS



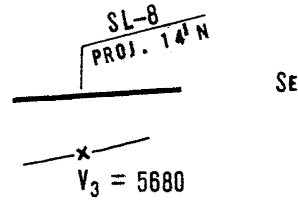
EXPLORATION HOLE WITH COLLAR ELEV., DISTANCE PROJECTED TO SECTION, WATER LEVEL, DATE, ELEV., SOLID TRIANGLE IS DEPTH WATER FIRST ENCOUNTERED WITH DATE, ELEV.



EXPLORATION TRENCH, WITH DISTANCE PROJECTED TO SECTION, GEOLOGIC UNITS

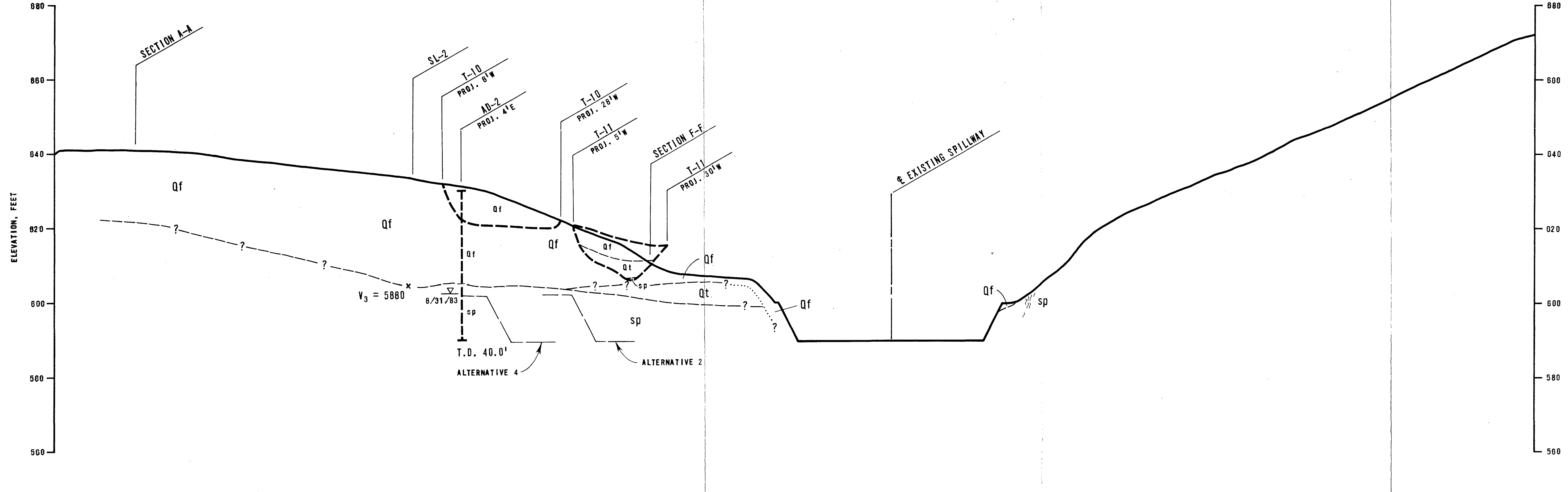


TEST PIT WITH GEOLOGIC UNITS, WATER LEVEL AND DATE



SEISMIC LINE WITH DISTANCE PROJECTED, APPROXIMATE LOCATION OF SEISMIC VELOCITY LAYER AND VELOCITY FOR INDICATED LAYER.

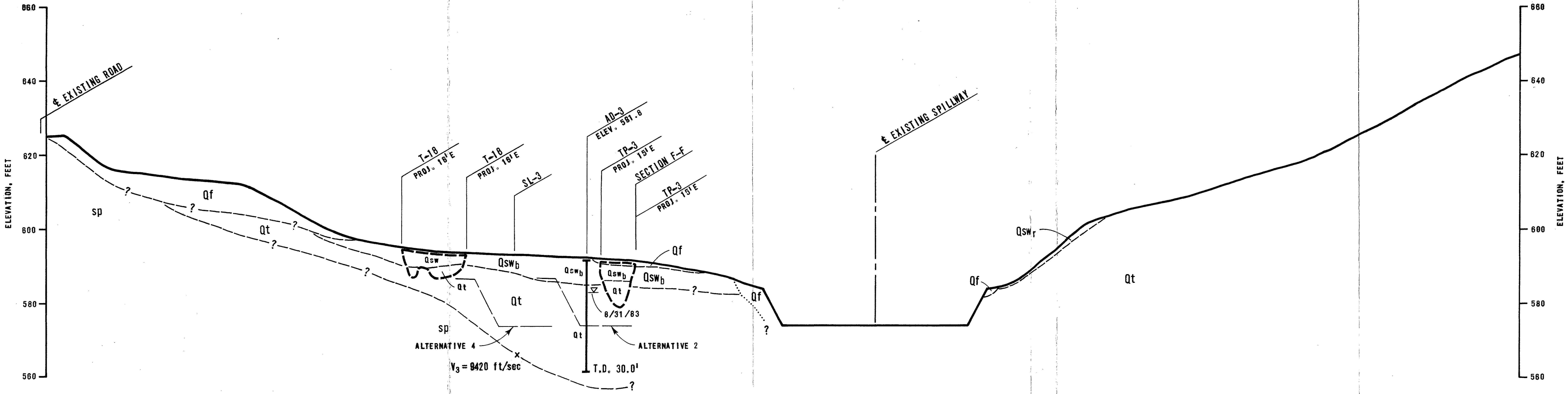
Wahler Associates	ANDERSON DAM SPILLWAY ENLARGEMENT	GEOLOGIC SECTION A-A		
		PROJECT NO.	DATE	FIGURE NO.
	PALO ALTO • NEWPORT BEACH • CALIF.	SCV-124A	OCTOBER 1983	III-3



SCALE
20 0 20 FEET
HORIZONTAL AND VERTICAL

NOTES:
1. SEE FIGURE III-2 FOR LOCATION OF SECTION.
2. SEE FIGURE III-3 FOR EXPLANATION.

Wahler Associates	ANDERSON DAM SPILLWAY ENLARGEMENT	GEOLOGIC SECTION B-B		
		PROJECT NO.	DATE	FIGURE NO.
	PALO ALTO • NEWPORT BEACH • CALIF.	SCV-124A	OCTOBER 1983	III-4



SCALE

20 0 20 FEET

HORIZONTAL AND VERTICAL

NOTES:
1. SEE FIGURE III-2 FOR LOCATION OF SECTION.
2. SEE FIGURE III-3 FOR EXPLANATION.

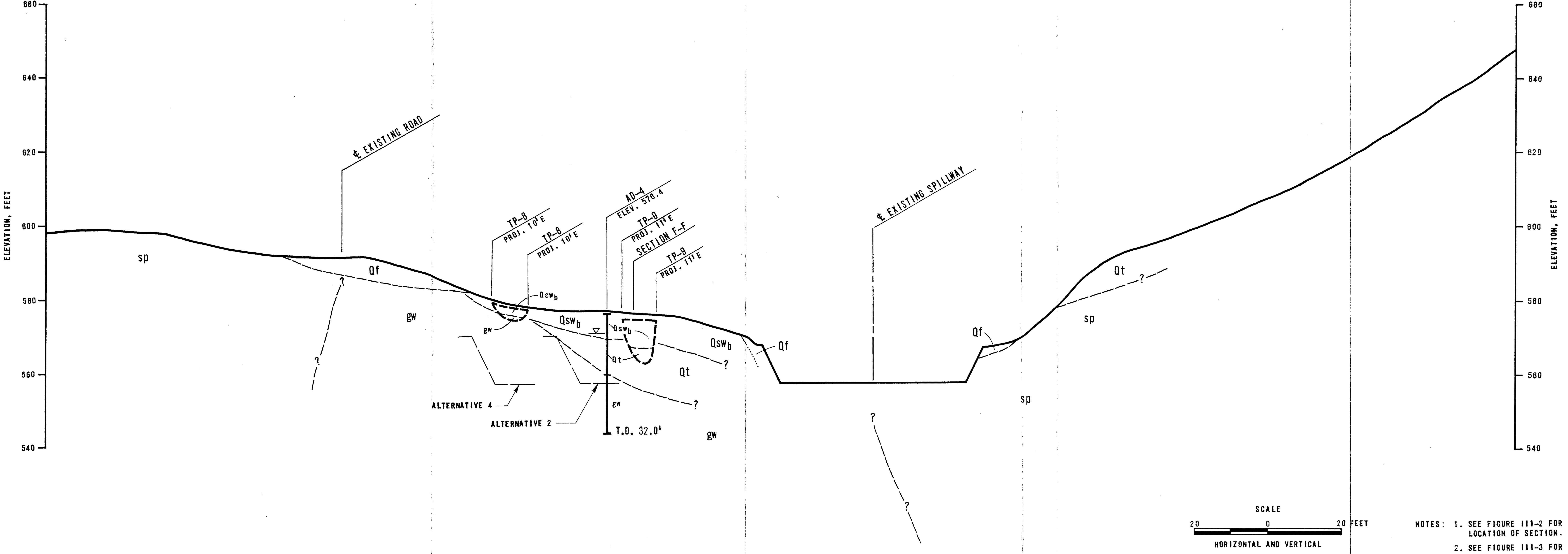
Wahler Associates

ANDERSON DAM
SPILLWAY ENLARGEMENT

PALO ALTO • NEWPORT BEACH • CALIF.

GEOLOGIC SECTION C–C

PROJECT NO.	DATE	FIGURE NO.
SCV-124A	OCTOBER 1983	III-5



NOTES:
1. SEE FIGURE III-2 FOR LOCATION OF SECTION.
2. SEE FIGURE III-3 FOR EXPLANATION.

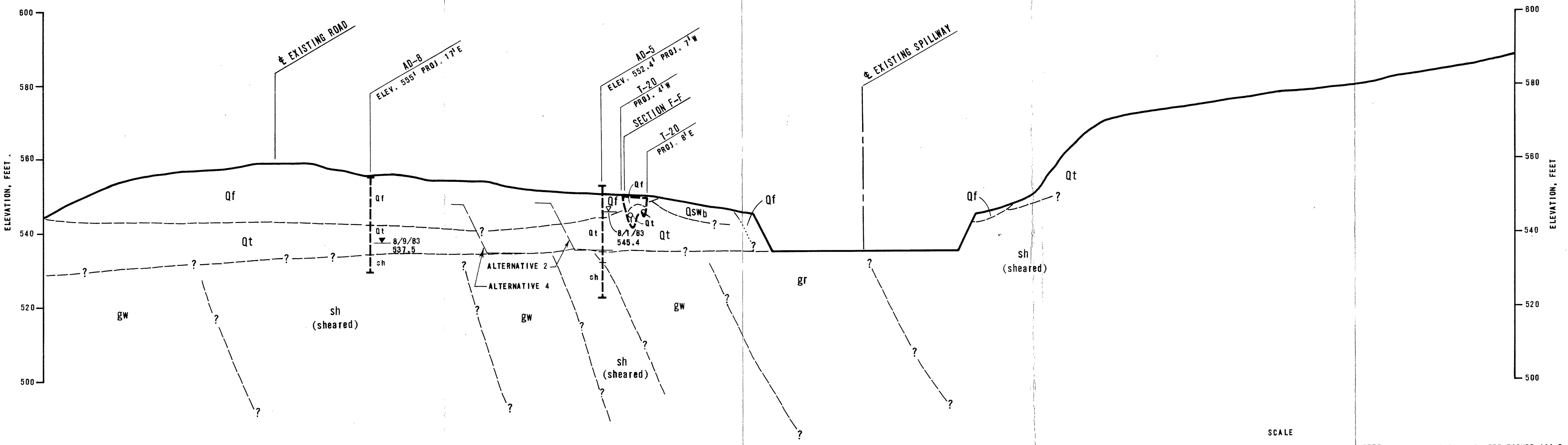
Wahler Associates

ANDERSON DAM
SPILLWAY ENLARGEMENT

PALO ALTO NEWPORT BEACH CALIF.

GEOLOGIC SECTION D-D

PROJECT NO.	DATE	FIGURE NO.
SCV-124A	OCTOBER 1983	III-6



SCALE

20 0 20 FEET

HORIZONTAL AND VERTICAL

NOTES:
1. SEE FIGURE III-2 FOR LOCATION OF SECTION.
2. SEE FIGURE III-3 FOR EXPLANATION.

Wahler Associates	ANDERSON DAM SPILLWAY ENLARGEMENT	GEOLOGIC SECTION E-E		
		PROJECT NO.	DATE	FIGURE NO.
	PALO ALTO ● NEWPORT BEACH ● CALIF.	SCV-124A	OCTOBER 1983	III-7

NOTES: 1. SEE FIGURE III-2 FOR LOCATION OF SECTION.
2. SEE FIGURE III-3 FOR EXPLANATION.

SCALE
20 0 20 FEET
HORIZONTAL AND VERTICAL

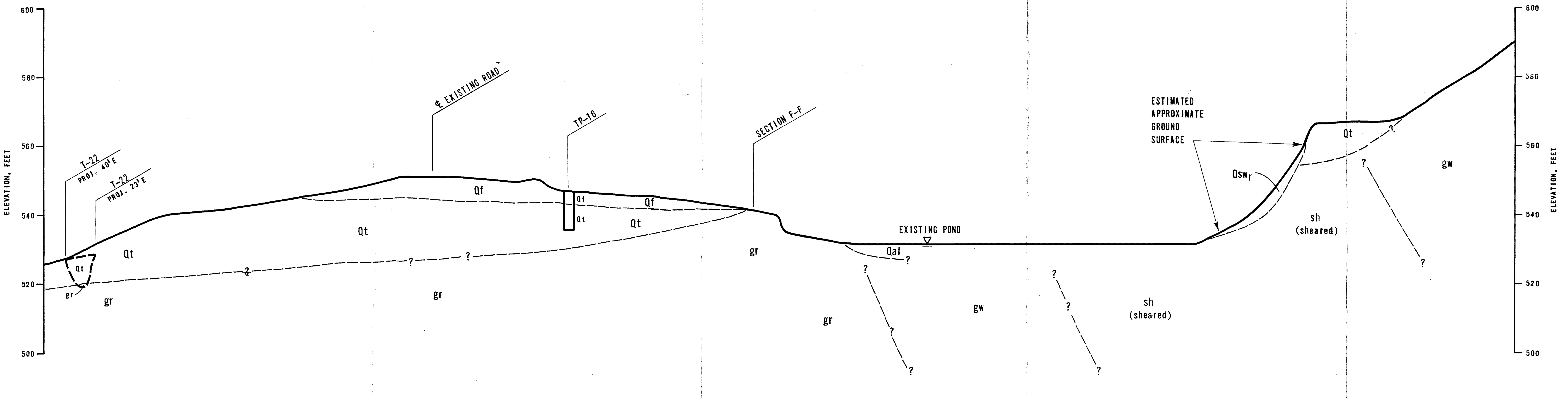
Wahler Associates

ANDERSON DAM
SPILLWAY ENLARGEMENT

PALO ALTO NEWPORT BEACH CALIF.

GEOLOGIC PROFILE F-F

PROJECT NO.	DATE	FIGURE NO.
SCV-124A	OCTOBER 1983	III-8



SCALE

20 0 20 FEET

HORIZONTAL AND VERTICAL

NOTES:
1. SEE FIGURE III-2 FOR LOCATION OF SECTION.
2. SEE FIGURE III-3 FOR EXPLANATION.

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ANDERSON DAM
SPILLWAY ENLARGEMENT

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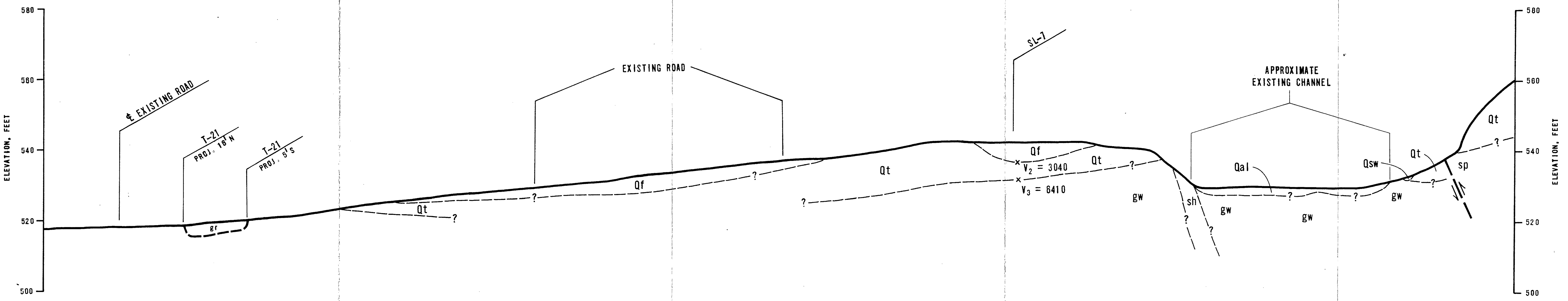
GEOLOGIC SECTION G-G

PROJECT NO.	DATE	FIGURE NO.
SCV-124A	OCTOBER 1983	III-9



SCALE

20 0 20 FEET

HORIZONTAL AND VERTICAL

NOTES: 1. SEE FIGURE III-2 FOR LOCATION OF SECTION.
2. SEE FIGURE III-3 FOR EXPLANATION.

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ANDERSON DAM
SPILLWAY ENLARGEMENT

PALO ALTO • NEWPORT BEACH • CALIF.

GEOLOGIC SECTION H-H

PROJECT NO.	DATE	FIGURE NO.
SCV-124A	OCTOBER 1983	III-10

map. Work by Woodward-Lundgren & Associates (1973) along the Coyote Creek fault northwest of the site, suggests early Pleistocene movement on a portion of this structure.

Surface and subsurface exploration performed as part of this investigation found evidence for faults and shear zones at the site. (A fault is defined in the American Geological Institute Dictionary of Geological Terms as a "fracture or fracture zone along which there has been displacement of the sides relative to one another parallel to the fracture." A shear zone is defined as a "zone in which shearing has occurred on a large scale so that the rock is crushed and brecciated.")

Much of both the serpentine and shale observed at the site appears to have been pervasively sheared. Shearing in the serpentine exposed in the approach channel exhibits a northwesterly trend. In contrast, the shearing in the shale and serpentine in the open discharge channel exhibits a northeasterly trend, except for apparently local distortions around masses of graywacke. This pervasive shearing, which is characteristic of much of the serpentine and shale in the Coast Ranges, is considered to be very old and may have developed during subduction of the Franciscan and intrusion of the serpentine.

A narrow (about 50 feet) zone of faulting mapped on the approach channel (Figure III-1) may be a trace of the Coyote Creek fault. The zone is bounded on the south by a small fault characterized by a distinct white gouge, which is exposed in Trenches T-3 and T-5 (excavated into serpentine) and appears to pass about 80 feet northeast of the spillway control structure. To the northeast, other seams of white gouge are exposed in the serpentine comprising a portion of the cut slope bordering the approach channel. The area, logged as Trench T-8, is about 100 to 110 feet from the spillway control structure. In this area, the gouge seams are definitely truncated by the terrace deposit which overlies the serpentine.

Somewhat further northeast, along a portion of oversteepened cutslope logged as Trench T-9, serpentine is displaced over a basal unit in the terrace deposit. The displacement (reverse sense) has occurred on a number of apparently small, northeast trending faults truncated along strike by northeasterly trending structures. None of the structures were traceable above the basal unit of the terrace deposit. Based on soil-stratigraphic evidence (Shlemon, 1983, Appendix C, this report), the last displacement of the faults exposed in Trench T-9 is considered to have taken place at least 100,000 years ago.

At a separate location on the north side of the open discharge channel (Location 8-2, Figure III-2), graywacke and serpentine are displaced (reverse sense) over a basal terrace deposit similar in age to that in Trench T-9 (Ibid.). The displacement appears to have taken place on northeast trending, reverse faults mapped along the base of the slope on the north side of the channel.

The northeasterly trend, which is not consistent with the regional tectonic grain, was also noted in Franciscan age rocks in this area. The reason for -- and extent of -- this perturbation is not known. Northeast trending faults were also encountered in Franciscan rocks in Trench T-21 about 280 feet south of the channel. However, northwesterly trending faults were encountered in the Franciscan age rocks in Trench T-22 about 120 feet northeast of T-21. Sheared Franciscan rocks were encountered in a number of exploratory holes, but the orientation of the shearing was not determined.

The geologic evidence gained from this investigation indicates that the only trace of the Coyote Creek fault which demonstrably passes through the study area is in the approach channel. The northeast trending fault in the open discharge channel is of similar age and sense of displacement and is likely a part of the Coyote Creek fault system. No other evidence for faulting which could be ascribed to the Coyote Creek fault was discerned. However, it is possible that other traces of northwest trending faults could be concealed by alluvium, fill, and/or terrace deposits south of the discharge channel and change strike, to the northeasterly trend, in the discharge channel area. Examination of stereo airphotos taken in 1939 shows no such trend. Excavation for the enlarged spillway channel may provide exposures which resolve this question.

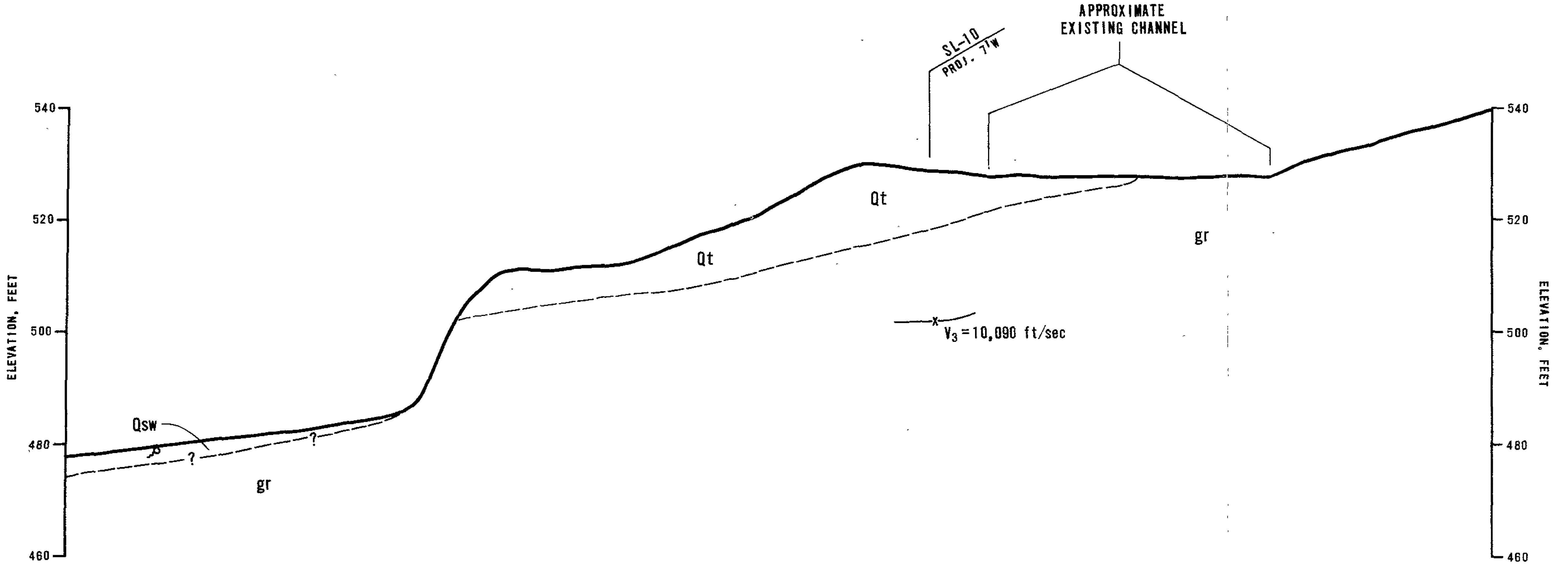
E. STABILITY OF NATURAL SLOPES

The geologic investigation of the proximate spillway area suggests that there are no deep seated, active landslides in the slope above the spillway channel. This contention is supported by the following:

- No distress attributable to such a mass movement has occurred in the lined spillway channel, which would be the toe area of a large slide.

- A larger, deeper slide would be blocked (buttressed) by the bedrock ridge south of and parallel to the small valley in which the lined channel is sited.

- The scarp at the head of the larger slide area shown on Wagner's map (Figure II-5) is probably a result of differential erosion between the resistant silica carbonate rock to the north and the more erodible serpentine which underlies the slope north of much of the lined channel.



SCALE

20 0 20 FEET

HORIZONTAL AND VERTICAL

NOTES:
1. SEE FIGURE III-2 FOR LOCATION OF SECTION.
2. SEE FIGURE III-3 FOR EXPLANATION.

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ANDERSON DAM
SPILLWAY ENLARGEMENT

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GEOLOGIC SECTION I-I

PROJECT NO.	DATE	FIGURE NO.
SCV-124A	OCTOBER 1983	III-11

FOUNDATION CONDITIONS

CHAPTER IV

FOUNDATION CONDITIONS

A. SPILLWAY CONTROL STRUCTURE

The proposed enlarged spillway control structure will be located across the same saddle occupied by the present structure. The new structure will replace the existing structure entirely. The greater length of the new structure will be accommodated, in part, by excavation into the embankment at the left of the present structure.

Exploration for the control structure included 1 bore hole, 2 seismic refraction lines, 3 exploration trenches, and geologic mapping. The locations of these explorations are shown on Figure III-1.

Varying thicknesses of fill overlie serpentine in the control structure area. In the approach channel, along the upstream edge of the existing structure, the thickness varies from essentially zero to about one and one-half feet. Trench T-6, near the left abutment of the existing control structure, encountered about one and one-half feet of loose fill overlying the serpentine (Figure III-3). Hole AD-1, drilled from the crest of the earth dike which forms the left abutment for the existing structure, penetrated 24 feet of embankment before encountering the serpentine at about Elevation 616. In this area, the fill consists of reddish-brown, apparently dense, gravelly clayey sand and sandy clay, probably derived from older colluvial soils and other terrace deposits. In general, the serpentine is severely weathered, crushed, friable to weak and soft; some is intimately slickensided and has the appearance of having been sheared. The serpentine was excavated easily with a JD-450C backhoe. Low to moderate seismic velocities in seismic lines (SL-1 and SL-11) suggest that serpentine could probably be excavated without blasting.

The water table in the area of the proposed control structure appears to be strongly influenced by the reservoir level.

B. SPILLWAY CHANNEL

The proposed spillway channel enlargement will adjoin the present spillway channel along its south side. The spillway channel (both existing and proposed) is along a small valley which drains westward and is separated from the Coyote Creek drainage by a small ridge. Exploration of the spillway channel included 8 drill holes, 4 seismic lines, 11 exploration trenches, 15 test pits, and geologic mapping (Figure III-2).

Geologic units encountered along the spillway channel include fill, slopewash, terrace deposit, Franciscan complex, and serpentine.

Fill - As much as 24 feet of fill were encountered (in Hole AD-5) along the proposed spillway channel. The areas of thickest fill appeared to be at the upper and lower ends of the alignment (Figure III-4, Figure III-7, and Figure III-8).

Hole AD-2, approximately 115 feet left (south) of centerline of the existing spillway at Station 4+00, encountered 24 feet of fill. Hole AD-5, approximately 72 feet left of centerline of the existing spillway at Station 11+00, encountered 17 feet of fill. Much of this fill consists of clayey sand and clayey gravel and appears to have been derived from serpentine. A large graywacke boulder was encountered in Trench T-19, however. Fill will be encountered in cuts in some areas. No fill is anticipated at invert.

The fill should be removable by common excavation, except that large boulders, such as encountered in Trench T-19, would probably require blasting for removal.

Slopewash - Geologically recent colluvial deposits, referred to as slopewash, were encountered along the alignment of the proposed spillway channel enlargement (Figure III-2). The slopewash, which consists largely of dark brown to black, moderately to highly plastic clays, and also contains some cobbles and boulders, extends from opposite about Station 4+25 to opposite Station 11+00 and may be as much as 10 feet thick (Figures III-4, III-5, III-6 and III-7). Laboratory testing indicates that soils have a moderate swelling potential. The slopewash will likely comprise portions of the cut slopes on the south side of the proposed excavation, approximately between Stations 5+50 and 8+50. No slopewash is anticipated at invert grade, however.

It is anticipated that the slopewash can be removed by common excavation.

In addition to those deposits along the alignment of the proposed channel enlargement, thin, very recent, slopewash deposits occur along the right (north) side of the existing channel between Stations 4+75 and 6+75. These latter deposits consist of red-brown, clayey sands which have accumulated along a section of slope cut into terrace deposits above the existing channel wall.

Terrace Deposit - Geologically older colluvial and alluvial deposits, referred to as terrace deposit, are possibly correlative with the ubiquitous Santa Clara formation, and occur along the existing spillway channel. The terrace deposit, which consists largely of sandy clay and clayey sand, crops out along the right (north) side of the existing channel between Stations 4+75 and 6+75 and between Stations 8+75 and 11+00 (Figure III-2). Although the terrace deposit does not crop out on the left (south) side of the existing channel, the area of the proposed spillway enlargement, it was encountered in the exploration for the enlargement between Stations 3+70 and 11+00 (Figures III-4, III-5, III-6, III-7, and III-8). In the area of the channel enlargement, the terrace deposit was encountered at depths of 3 to 16 feet, and overlain, in general, by slopewash, except along the lower portions of the proposed work, where it is overlain by fill (Figure III-7). In the area of the enlargement, the terrace deposit consists largely of clayey sand and sandy clay, although some sandy gravel was encountered in Hole AD-5 and in Trench T-20. The thickness of the terrace deposit exceeded 23 feet in Hole AD-3. The terrace deposit will comprise significant portions of the invert and of the cut slopes for the enlargement, including a thick section roughly between Stations 4+40 and 6+60 and thinner, somewhat irregular areas between Station 7+70 and 11+00.

It is anticipated that common excavation methods can be used in the terrace deposit, although some heavy ripping may be required if cemented layers or zones are encountered.

Franciscan Complex and Serpentine - Franciscan complex and serpentine underlie the spillway channel and proposed channel enlargement, but crop out only along portions of the north side of the existing channel and along portions of the present dam egress road, largely outside the area of excavation (Figure III-2). Serpentine crops out approximately between Stations 3+50 and 4+75 and between 6+75 and 8+75 on the north side of the existing spillway channel. No Franciscan rocks crop out on the north side of the channel, although sheared shale is exposed in a cut on the north side at the downstream end of the channel section.

Serpentine was encountered beneath the channel section from the control structure to Station 5+25, and is believed to comprise the bedrock to about Station 6+50 (Figure III-8). The serpentine encountered in the drill holes and trenches is typically crushed, friable to weak, and soil-like, although it retains a rock structure. Much of the serpentine is sheared and intimately slickensided. Despite these prevalent observed conditions, indirect evidence -- seismic velocities from seismic lines SL-3 and SL-8 believed to be above the serpentine -- suggests that there could be some moderately hard, weak to moderately strong masses in the serpentine. Serpentine will probably be encountered along the channel enlargement from the control structure to about Station 4+40 and most likely will be the invert foundation and at least the lower part of the cut slopes in that area.

Franciscan complex was encountered beneath the channel section between Stations 7+00 and 11+00, and is believed to extend from Station 6+50 to Station 11+00 (Figure III-8). Graywacke is the most common rock type in the channel section below Station 6+50. Intervals of shale were encountered in some drill holes. No other rock types were encountered in the channel section, but geologic mapping suggests that greenstone may extend into the lowest part of the channel section (Figure III-2). The graywacke varies from severely weathered, friable, and soil-like (very dense) to little weathered, moderately hard, moderately strong rock. The variation apparently occurs laterally, as well as vertically. The shale is typically crushed and/or sheared, and soil-like (hard). The condition of the greenstone in the channel section is not known, but based upon exploration west of the spillway channel, it could vary from hard to friable, strong to soft. Franciscan complex will probably be encountered along the channel enlargement from about Station 6+50 to Station 11+00 and will comprise a large portion of the invert and portions of the cut slopes in that area.

It is anticipated that common excavation can be used in much of the Franciscan complex and the serpentine. However, heavy ripping and/or local blasting may be necessary to break the less weathered and less fractured masses of graywacke and greenstone and massive serpentine to facilitate excavation. It is anticipated that the finished excavation grade would be irregular, more so in the less weathered rock. Overbreak of up to 12 inches is possible, locally, with an average overbreak on the order of 3 inches.

Ground Water - Artesian ground water was encountered near the invert grade for the channel enlargement in Holes AD-6, AD-7, and AD-9 (Figure III-8). These holes were drilled with a flight auger and were backfilled shortly after completion; in each, the water level rose above the elevation at which it was first encountered. The amount of rise varied for each hole, perhaps as a function of the length of time the hole was open and the permeability of the material. In Hole AD-9, the water was encountered in terrace deposit at 15 feet and rose to 6 feet. This latter depth is consistent with the levels measured in piezometers installed in Holes AD-3, AD-4, and AD-5, which indicate a piezometric surface about 10 feet above invert. The amount of rise in Hole AD-6 was about 3 feet and in AD-7 about 0.5 foot. Water was also encountered in Trenches T-11 and T-12. Seepage conditions will be discussed in detail in Chapter V.

C. SPILLWAY TERMINAL STRUCTURE

A terminal structure will be located at the downstream end of the lined spillway channel enlargement approximately between Stations 11+00 and 11+15 (Figure III-2). The structure will likely consist of a cutoff wall, a drainage system, concrete invert and wall slabs, and some form of energy dissipating structure. The cutoff wall could extend about 10 feet below invert grade.

Exploration in the area of the terminal structure included geologic mapping, excavation of one test pit and one exploration trench, and drilling one bore hole. The location of this exploration is shown on Figure III-2.

Geologic units encountered at the terminal structure include fill, slopewash, terrace deposit, and Franciscan complex.

Fill - Eight feet of fill was encountered in Hole AD-5 proximate to the terminal structure. The fill appears to have been derived from serpentine and consists of gravelly clayey sand and clayey gravel with some cobbles and boulders. The fill extends southerly from about 30 feet left of the existing terminal structure and appears to thicken to the south (Figure III-7). No fill will be encountered at invert grade. However, the upper portion of the wall section and some cut slope will likely be in fill material.

Fill can be removed by common excavation, although large boulders could require special handling.

Slopewash - Recent colluvial deposits, slopewash, were mapped in a small portion of the terminal structure area (Figure III-2). The slopewash is part of the same unit described in Section B, above, and consists largely of sandy clay with medium to high plasticity. The thickness of the slopewash near the terminal structure is not known, but it is probably on the order of 4 to 6 feet.

The slopewash can be removed by common excavation.

Terrace Deposit - Terrace deposit (older alluvial and colluvial deposits) was encountered only in subsurface exploration at the terminal structure. The terrace deposit, which is overlain by slopewash and fill, occurs at depths from 1.5 to 18 feet and consists primarily of clayey sand with varying minor amounts of gravel and some lenses of sandy gravel and gravelly sand. In Hole AD-5, 9 feet of terrace deposit was encountered, including 7 feet of gravelly clayey sand and 2 feet of a basal, sandy gravel. In Trench T-20, terrace deposit was encountered at 1.5 feet and included a lense of sandy gravel with cobbles within a larger accumulation of clayey sand.

The terrace deposit will likely be encountered in at least portions of the slab invert and in the cut slopes. It is anticipated that excavation for the cutoff wall will fully penetrate the terrace deposit and extend well into the underlying Franciscan complex.

Common excavation methods can be used in the terrace deposit, although heavy ripping may be required if cemented zones are encountered.

Franciscan Complex - Franciscan complex underlies the terminal structure area at about slab invert grade. Rocks of the Franciscan complex were encountered in Hole AD-5 and are exposed around the edge of the pool at the end of the existing spillway. Sheared shale is exposed in the undermined portion of the right cutoff wall. Hard, strong, slightly weathered graywacke, soft to moderately strong shale with pervasively fractured intervals, and soft, sheared to moderately hard greenstone are believed to comprise the Franciscan complex at the terminal structure. Graywacke and shale were encountered in Hole AD-5, and greenstone was mapped on the south side of the pool (Figure III-2).

Slab invert and subdrains will likely be excavated partly in terrace deposit and partly in Franciscan complex. The cutoff wall will probably be excavated almost entirely in Franciscan complex.

Common excavation methods can be used in much of the Franciscan complex at the terminal structure. Heavy ripping and/or blasting may be necessary to break the less weathered and less fractured masses of graywacke and greenstone which may be encountered. Similar overbreak conditions previously mentioned for the spillway channel excavation are possible in the terminal structure in bedrock materials.

Ground Water - Ground water should be anticipated in the excavations for the terminal structure. Water was encountered in Trench T-20 at about 6 feet, and the piezometric level in Hole AD-5 is about 8 feet below the ground surface, both on the order of 10 feet above the slab invert.

D. OPEN DISCHARGE CHANNEL

The existing open discharge channel extends westerly from the end of the spillway terminal structure to the lip of a man-made bluff overlooking Coyote Creek, a distance of about 820 feet. The channel was apparently excavated across a gently sloping shelf and does not occupy a pre-existing channel. A "plunge pool"-like feature approximately 100 feet in diameter has developed at the head of the open discharge channel below the existing terminal structure. The dimensions of an enlargement for the open discharge channel have not been defined.

Exploration relevant to the open discharge channel included 5 seismic refraction lines, 4 test pits, and geologic mapping (Figure III-2). Geologic units which occur along the open discharge channel include such very recent surficial deposits as fill, alluvium, and slopewash, as well as terrace deposit, and Franciscan complex and serpentine.

Very Recent Surficial Deposits - Very recent surficial deposits occur along the existing open discharge channel and appear to have been emplaced since construction of the discharge spillway. The thickness of these deposits is probably on the order of 4 to 6 feet, although in places, the fill may be 10 to 15 feet thick. Widening and/or deepening of the existing discharge channel to accommodate the design flood would require excavation in these surficial materials. It appears (Figures III-9, III-10, and III-11) that these surficial deposits would be removed from any enlarged discharge channel section and would remain only in the upper portions of some of the cutslopes. Common excavation methods could be used to remove the very recent surficial deposits except that the very large boulders from recent rock falls might require light blasting or other special treatment for removal.

Terrace Deposit - Terrace deposit, largely of colluvial origin, occurs above much of the left bank of the existing discharge channel, in places along the right side of the channel (Figures III-9 and III-10), and is exposed in the channel between 70 and 260 feet behind the lip of the bluff (Figure III-2 and Figure III-9). The terrace deposit consists largely of clayey sand with varying amounts of gravel and appears to be poorly indurated.

An enlarged open discharge channel would likely include excavation in terrace deposit along the entire left side of the discharge channel. Depending on the configuration of the channel, it appears that the terrace deposit will occur largely in the cutslopes somewhat above channel grade, except that from about 260 feet back (up the channel) from the lip of the bluff to about 70 feet back of the lip, part (Figure III-9) or all (Figure III-2) of the discharge channel would be in terrace deposit.

In general, common excavation methods could be used to excavate terrace deposit, although heavy ripping might be necessary in certain weakly cemented zones.

Franciscan Complex and Serpentine - Franciscan complex and some serpentine underlie the existing open discharge channel. These bedrock units crop out in the existing discharge channel, are exposed in the channel banks (Figure III-2), and were encountered in exploration trenches in the area (Figure III-9). The Franciscan units include graywacke, greenstone, and shale. The graywacke and greenstone predominate and vary from hard, strong, and nearly massive to friable, weak, and crushed. The shale, as well as the serpentine, is usually found in an intensely fractured to crushed and/or sheared condition. Serpentine exposures are of small extent in the discharge channel area. Evidence for preferential erosion can be seen along certain of the crushed zones. Mass wasting has occurred at the right side of the "plunge pool", probably as a result of erosion and oversteepening of the crushed and/or sheared shale along the lower part of that slope.

Franciscan complex would comprise nearly all of the lower cut slopes and much of the invert of an enlarged discharge channel, except for the interval of terrace deposit 70 to 260 feet behind the lip of the bluff. Seismic refraction surveys, SL-4, SL-6, and SL-7, left of the existing channel, and geologic mapping suggest that the terrace deposit/Franciscan complex contact slopes down to the south (Figures III-9 and III-10), and certain configurations for an enlarged discharge channel could encounter terrace deposit at the base of the cutslope and in the invert, in addition to the area mentioned above. Low to moderate seismic velocities in these seismic refraction surveys suggest that in the area of the seismic work, at likely depths of excavation (20 to 30 feet) the rock is probably moderately weathered and fractured. In contrast, the higher seismic velocity recorded in seismic line SL-10 suggests that the greenstone in that area is probably relatively fresh, hard, and little fractured, much like the greenstone comprising the bluff.

Excavation for the open discharge channel in the Franciscan complex will require moderate to hard ripping with blasting of certain localized hard masses of graywacke and greenstone. In particular, the large greenstone mass from the lower end of the channel to the bluff will require blasting.

Erosion protection will probably be necessary along much of the left side of an enlarged discharge channel for both the Franciscan complex and terrace deposit. Erosion protection and slope stabilization are also indicated for the right side of the existing "plunge pool".

Ground Water - Existing seepage from the spillway and from above the right side of the existing discharge channel provide a constant flow along the channel. Water should be anticipated in excavation for an enlarged discharge channel at, or below, the grade of the existing discharge channel.

SEEPAGE CONDITIONS

CHAPTER V

SEEPAGE CONDITIONS

A. GENERAL

An assessment of the ground water and seepage conditions in the area of the existing spillway and proposed spillway enlargement was undertaken as part of the geotechnical investigation. The purposes of this seepage evaluation are: (1) to provide recommendations for water control during construction and to recommend a maximum reservoir level that could be maintained during construction without creating major problems related to seepage, and (2) to provide design recommendations for the long-term control of seepage in the proposed spillway enlargement. We have, therefore, conducted a program of periodic monitoring of drain holes in the existing spillway and installed and monitored water levels in observation wells. We have also reviewed available information on the seepage conditions during periodic inspections by representatives of the State of California Division of Safety of Dams.

B. HISTORY

A review of the seepage conditions in the right abutment and spillway area during the operation of Anderson Dam would be helpful in the assessment of seepage conditions related to the proposed spillway enlargement.

Seepage in the right abutment ridge, prior to the installation of a subdrain in 1959, has been documented in inspection reports by representatives of the Division of Safety of Dams, as listed chronologically below:

> April 17, 1952: Memorandum to Mr. W.H. Holmes from C.J. Cortright. Reservoir at spillway level. Strong seepage observed "seeping through the right abutment ridge below the low spur fill running to the spillway. The ground between this fill and the spillway channel is generally seeping with many points of concentrated flow extending from near the spillway entrance to --- some 300 feet or so downstream of the spillway weir".

"Many of the drains of the left spillway wall in this 300 feet stretch were flowing quite heavily. Some of the hair cracks in the lining are also seeping for 1/2 to 3/4 of wall height."

"Five left floor drains in the 1st row below the weir were flowing strongly."

December 4, 1952: Memorandum to Mr. W.A. Brown from D.S. Cleavenger and D.F. Dresselhaus. Reservoir surface elevation about ±8 feet below spillway lip (~ 197gpm). A sketch map showing flowing weep holes, prepared as part of this December 1952 inspection, indicates similar distribution of seepage as that observed during our monitoring at reservoir Elevation 615.

August 12, 1954: Memorandum to Mr. W.A. Brown by W.A. Brown, C.J. Cortright and A.M. McClure. Reservoir water surface at Elevation 580. No seepage in the vicinity of the right wing levee and the spillway except for a flow from the four central drain pipes in the last row of drains in the spillway at about Elevation 537.

May 8, 1956: Letter to Board of Directors, Santa Clara Valley Water Conservation District (SCVWCD) from California Department of Water Resources (DWR); noting excessive leakage on a large area to the left of spillway channel during full reservoir level and expressing concern over large hydrostatic pressure on the left spillway wall as well as uplift on the large spillway slab.

July 30, 1959: Letter to Mr. J. Robert Roll (SCVWCD) from California DWR; acknowledging receipt of plan for proposed subdrain at Anderson Dam in the vicinity of spillway.

October 5, 1959: Letter from Mr. John Beaudet (SCVWCD) to California DWR; stating that subdrains were installed on the left side of Anderson spillway (the approximate location of this subdrain is shown on Figure V-1 of this report).

September 29, 1980: visual inspection by Division of Safety of Dams (in Phase I Inspection report, Leroy Anderson Dam, dated April 1981. Reservoir surface elevation at 611.9 feet. "The drainage for the spillway channel was dry from the crest to approximately Station 7+00 (Elevation 567) two weepholes were passing about 5 gpm each, and at approximate Station 10+00 (Elevation 543) two weepholes were passing about 10 gpm each. At the terminal end of the concrete channel, 2 of the 6 drain outfalls were passing a total estimated flow of 20 gpm. These outfalls are from the 12-inch thick rock drain beneath the downstream 200 feet of the channel invert."

Our assessment of seepage conditions along the lined spillway channel during this investigation shows that the zone and elevation of seepage at various reservoir surface elevations has been consistent since operation of the reservoir began.

C. FIELD MEASUREMENTS

Spillway Drain Holes

The drain holes in the existing lined spillway channel were monitored on a monthly basis from June to December, 1983, to measure the amount of flow from these holes. Measurements were performed by inserting a plastic hose or pipe snugly into the drain hole and measuring the flow in a calibrated container. In addition, a portable wooden weir was installed at the terminal end of the spillway to estimate total flow; however, these weir measurements were discontinued after 3 readings because of damage to the weir. It also became apparent that a summation of measured flows from all the drain holes provided a more meaningful total flow measurement. Table V-1 shows seepage measurements from drain holes that were passing 1 gpm and greater flows. The locations of these drain holes are shown on Figure V-1.

Observation Wells

Five holes drilled to assess subsurface conditions along the proposed spillway enlargement area were converted to observation wells in order to monitor the ground water level along the alignment. The locations of these observation wells are shown on Figures III-2 and V-1. The wells were constructed using 2-inch diameter Schedule 40 PVC pipe with slotted tips. The construction procedure is included in Appendix A of this report and is summarized in the Piezometer Data Summary Sheet provided by the District and also included in Appendix A.

District Weir

A weir was installed by the District at the plunge area on the downstream end of the open spillway channel in July 1983. The weir measurements taken by the District are shown on Table V-3 and plotted on Figure V-2.

D. DISCUSSION

Figure V-2 shows the relationship of water level in observation wells and flow from the spillway drain holes to reservoir surface elevation. This graph was developed from reservoir surface elevations provided by the District, observation well readings from Table V-2, flow measurements from Table V-1, and the District weir readings from Table V-3. Only drain holes with flows of 1 gpm and greater were measured. Several drain holes showed less than 1 gpm flow or traces of seepage; therefore, the total amount of flow shown on Figure V-2 and Table V-1 provides an approximation of total actual flows. We estimate that total actual flows were probably 20 percent greater than the total measured.

As shown on Table V-1 and Figure V-2, when the reservoir surface is at Elevation 619-620, measurable seepage occurs in the uppermost portion of the spillway channel. This represents the highest elevation of observed seepage during the monitoring program. All of these flows at the upper portion of the spillway were either from the left wall drain holes or the invert drain holes. The areas of measurable flows were from 5 drain holes on the left wall from Station 5+80 to 6+15 (Elevation 575 to 573). Another seepage area is located further upstream--from drain holes on the left wall from Station 4+00 to 4+25 (Elevation 590 to 587) and from the left row of invert drain holes at Station 4+00. The intervening area between these two seepage areas is relatively dry. At about reservoir Elevation 620, flows were noted from the second row of invert holes at Station 3+50 (Elevation 600). Prior to undertaking this study, we had also observed seepage from almost all the invert drain holes at Station 3+50 (Elevation 609) when the reservoir level was within 1-foot of the spillway crest on May 2, 1983. Similar observations were made by the Division of Safety of Dams on April 17, 1952, when the reservoir surface was at spillway level; where seepage in the "five left floor drains in the first row below the weir were flowing quite strongly".

At reservoir surface Elevation 615-616, the seepage line drops down to about Station 6+40 (invert Elevation 571). Strong seepage is concentrated in two general areas, with the heaviest combined flow emanating from the right wall drain holes of Panels 10 and 11 (Station 6+40 to 7+10; Elevation 571 to 566). Strong flows from some invert drain holes of Panel 10 (Station 6+40, Elevation 572) were also noted. On the left wall of the spillway, a few drain holes in Panels 10 and 11 (Station 6+85 to 6+50, Elevation 567 to 570) were passing water in significant amounts.

The other area of concentrated seepage is located near the downstream end of the spillway channel, mostly from invert drain holes in Panel 18 (Station 9+60, Elevation 546), Panel 19 (Station 10+00, Elevation 543), and a few of the invert holes in Panel 20 (Station 10+40, Elevation 540) and Panel 21 (Station 10+80, Elevation 537). Seepage observations during an inspection by representatives of the Division of Safety of Dams on December 4, 1952, show a similar distribution of seepage areas with the reservoir elevation at ~617. Upstream of Panel 10 the spillway channel was essentially dry.

At reservoir Elevation 612 the seepage line drops to Elevation 570 (Station 6+50) on the right wall of the spillway. The invert drain holes in Panel 10 (Station 6+40, Elevation 571) and the left wall drain holes are completely dry. As discussed previously, seepage occurs from the invert and left wall drain holes of Panel 10, when the reservoir surface is at Elevation 615.

At reservoir Elevation 601, the seepage line in the spillway channel is at Elevation 546 (Station 9+60), the lowest observed during the monitoring program.

Along the entire left wall, the areas of measurable seepage during high reservoir level (~Elevation 620) appear to be consistently located from about Station 4+00 to 4+25 (Elevation 590 to 587) and Station 5+80 to 7+30 (Elevation 575 to 565). As shown on Table V-1 and Figure V-2, the total measured seeapge from all left wall drain holes ranges from about 75 gpm to 2 gpm to trace gpm at reservoir surface Elevation 620, 612, and 601, respectively.

As shown on Figure V-2, the total measured seepage in the spillway channel correlates very well with changes in reservoir surface elevation. At reservoir surface Elevation 620, total measured flow is about 320 gpm, decreasing to about 130 gpm at Elevation 612 and about 90 gpm at Elevation 601.

The monitoring of water levels in observation wells (shown on Table V-2 and Figure V-2) indicates a close correlation with reservoir surface elevation. On Figure V-2, there is an immediate response to changes in reservoir surface elevation in observation wells AD-1 and AD-2 with a uniform head of 8 feet and 18 feet, respectively. This is at least the case when the reservoir level is above Elevation 610. It is not known whether this consistent response occurs at reservoir Elevation 601, because the water levels in AD-1 and AD-2 are apparently below the elevation of the observation well tips. In AD-3, AD-4, and AD-5, located in the downstream portion of the proposed alignment, there is a more subdued, but correlatable, response to changes in the reservoir surface elevation. In the profile on Figure V-1, the piezometric levels are shown in relation to proposed invert elevation at reservoir surface Elevations 620, 615, 612, and 601. At reservoir Elevation 620, the water level in AD-1, located at the proposed retaining structure, is about 7 feet (Elevation 612.5) above proposed invert (Alternative 2) and drops down to 3 feet (Elevation 604) below proposed invert when the reservoir elevation is at 612. In AD-2, the water level is below proposed invert when the reservoir surface elevation is about 605. Downstream of AD-2, the piezometric level is above invert at reservoir surface Elevation 601 and higher. It appears that the ground water is in part artesian downstream of AD-2. This artesian condition was evident while drilling auger holes AD-6 and AD-9 (Figure V-1, Profile).

E. CONCLUSIONS

Based upon the preceding discussion, the following conclusions can be made regarding the seepage conditions in the spillway area at Anderson Dam:

- A significant portion of the seepage in the spillway area is apparently related to reservoir leakage. Based upon our observation of seepage in the existing lined spillway, there is a direct correlation between the quantity of flow and reservoir surface elevation. For example, total flows of about 320 gpm and 130 gpm were measured at reservoir Elevation 620 and 612, respectively. At reservoir surface Elevation 601, the total flow is about 90 gpm. Although not measured, total flows on the order of 500 gpm are estimated at maximum reservoir level.

- It is very likely that an unknown quantity of seepage on the left side of the existing spillway bypasses the spillway drain holes. This is indicated by the water levels above the elevation of observed seepage in the existing spillway, in observation wells in the proposed spillway enlargement area; therefore, the quantity of seepage in the proposed spillway, after construction, may be greater than observed in the existing spillway.

- At high reservoir level (Elevation +619), the highest elevation of seepage along the existing spillway channel is at 600, although seeps have been reported from the first row of drain holes (Elevation 609) at maximum reservoir level. At reservoir surface elevation ~617, the seepage line drops down to about Station 6+40 (Elevation 572) and drain holes upstream of this station are dry. It can be concluded that when the reservoir level is near or on the approach channel bench (Elevation 620), seepage occurs in drain holes at the upstream end of the spillway. This indicates a direct seepage path from the approach channel beneath the spillway weir cutoff to the drain holes.

- At reservoir Elevation 612, there is a significant decrease in total flow to approximately 130 gpm, most of which emanates from drain holes on the right side wall from Station 7+10 to 6+50 (Elevation 565 to 570) and from the invert drain holes downstream of Station 9+50. At reservoir Elevation 601, the line of seepage is at Station 9+60, Elevation 546, and the total measured flow is about 90 gpm.

- There is a marked decrease in total flow from the left wall drain holes, from about 5 gpm at reservoir Elevation 612, to only traces of seepage at reservoir Elevation 601.

- The concentration of strong seepage downstream of Station 9+50 is probably attributable to a 12-inch rock blanket drain beneath the slab in the downstream 200-foot section of the lined spillway channel. This is indicative of the effectiveness of a rock blanket drain to control seepage in at least the same area of the proposed spillway enlargement.

- The concentration of seepage in the middle portion of the spillway from about Station 6+40 to 7+30 is probably associated with the contact between terrace deposit and Franciscan bedrock.

- The piezometric level, as measured in observation wells in the proposed spillway enlargement is above proposed invert at the upper end of the proposed spillway at reservoir Elevation 615 and higher, and is below invert at reservoir Elevation 612. Downstream of about Station 4+00, the piezometric level is above proposed invert at reservoir Elevation 612. The piezometric level is higher than the elevation of seepage from the adjoining drain holes. For example, at reservoir Elevation 601, the piezometric level ranges from 1-foot above invert (Elevation 574) at about Station 6+00 to almost 10 feet above invert (Elevation 546) at Station 11+00, and the seepage line on the existing spillway is at Elevation 546, Station 9+60. Upstream of Station 9+60, the drain holes are completely dry. This means that subsurface flow is bypassing the drains upstream of Station 9+60 and the existing drains may not be totally effective in controlling seepage.

- Control of seepage would be extremely difficult if the construction were to be performed at high reservoir elevation (+615), particularly in the south area of the spillway control structure. This would probably require a cofferdam along the entire width of the control structure and continuous pumping from the excavation.

F. RECOMMENDATIONS

Based upon the above conclusions, the following are our recommendations regarding control of seepage during construction and after completion of the proposed Anderson spillway enlargement.

- It has been demonstrated that the zone, elevation, and quantity of seepage is directly related to reservoir surface elevation. At high reservoir surface elevation (+619), seepage occurs at the uppermost drain holes and the total quantity of seepage is greater than 300 gpm. The piezometric level at reservoir Elevation 620 is about 7 feet above proposed invert in the proposed gravity section at the upper end of the spillway. As the reservoir surface elevation declines, the zone, elevation, quantity and piezometric level correspondingly decreases. At reservoir surface Elevation 612, the highest elevation of seepage is at 570, the total measured seepage is about 130 gpm and the piezometric level in the upper end of the spillway is 3 feet below proposed invert. Therefore, in order to significantly minimize the problem associated with seepage, we recommend a maximum reservoir elevation of 610 during the spillway construction. This would also correspond to the lowest elevation of the foundation grade for the proposed spillway weir structure for Alternative 4.

- At reservoir Elevation 612, the piezometric level along the proposed spillway enlargement is above proposed invert elevation downstream of ~Station 4+00. During construction with the reservoir surface elevation at 610, control of seepage in this area could be accomplished with a collector trench across the spillway alignment at about Station 4+00, and conveying the flow to the existing lined spillway channel. Other transverse interceptor drainage trenches could be constructed for dewatering purposes downstream of Station 4+00.

- Reservoir leakage will continue to occur in the spillway area during operation of the reservoir and could be quite significant during high reservoir level. Therefore, generous subdrain provisions should be considered during design. These should include a longitudinal subdrain trench, with perforated pipe, between the existing spillway and the proposed spillway addition. This subdrain would also serve to intercept seepage emanating from the existing spillway during construction of the spillway addition. A shallow longitudinal subdrain should be included along the toe of the left wall of the proposed spillway enlargement. In order to reduce potential hydrostatic pressure on the left wall a longitudinal subdrain, with perforated pipe, should also be included along the bench behind the proposed left wall of the spillway addition. As shown on Figure V-1, the existing subdrain on the left wall of the spillway (in the area of the proposed spillway enlargement) is shallow and intercepts seepage at and above the elevation of the existing left spillway wall. In order to be effective, the proposed subdrain should be taken down to the elevation of the spillway invert. If installed prior to completing excavation to invert grade, this will also help maintain cutslope stability during construction.

These recommended subdrains are in addition to the subdrainage provisions beneath the slab and behind the wall. The rock blanket drain at the downstream portion of the existing lined spillway has demonstrated its effectiveness and should also be included in the design of the spillway addition.

TABLE V-1

SEEPAGE MEASUREMENTS

Date of Measurement (1983) -		June 29	Aug. 1	Sept. 9	Oct. 12	Nov. 8	Dec. 15
Reservoir Surface Elev. -		615.88	619.92	619.0	615.56	612.26	601.67
Seepage Monitoring[1] Location No.	Approximate Elev. (nearest 1')	Flow[2] (gpm)	Flow[2] (gpm)	Flow[2] (gpm)	Flow[2] (gpm)	Flow[2] (gpm)	Flow[2] (gpm)
21-7	538	1	--	--	2	1.5	1.5
21-8	538	6	6	6	8.5	2.5	2
20-1	540	2	4	2	5	9	2.5
20-3	540	2	--	--	4.5	3	1.5
20-7	540	2	2.5	2	2	--	--
19-3	543	5	--	--	4.5	4	3
19-5	543	1	--	--	2	--	--
19-6	543	20	20	20	15	9	12
19-7	543	10.5	10.5	12	13	7	12
19-10	543	9.5	9.5	9	12	3	1.5
18-1	546	17	18	17	16	15	12
18-4	546	1	--	--	--	--	1
18-5	546	2	--	--	1	1.5	1.5
18-6	546	8	--	--	8	6	3
18-7	546	8	6	9	3.5	3	1
18-9	546	4.5	--	--	11	6	6
18-10	546	18	18	18	15	13.5	12
17R-8	546	--	--	--	7.5	4	--
16-2	552	1	1	1	--	--	--
15-2	556	1	--	--	--	--	--
13-2	562	1	1	1	--	--	--
13-10	562	1	--	--	--	--	--
12-4	565	--	--	--	2	1.5	--
12L-2	565	7	--	--	--	--	--
11R-4	567	14	14	12	6	2	--
11R-5	567	18	18	15	13.5	8	--
11R-6	566	12	12	8	3.5	2	--
11R-7	566	1	--	--	--	--	--
11L-2	568	7	6	6	4	1.5	--
10-4	571	1	6	2	3	--	--
10-6	571	1	--	6	1.5	--	--
10L-3	570	--	--	--	--	--	--
10L-4	570	--	--	--	--	--	--
10L-5	569	1	6	4	1	--	--
10L-6	569	5	8	10	4.5	--	--
10R-1	571	--	4	4	--	--	--
10R-2	571	--	2	10	--	--	--
10R-3	570	2	20	18	9	--	--
10R-4	570	18	18	18	7	6	--
10R-5	569	10	4	10	2	--	--
10R-6	569	14	14	12	12	6.5	--
9L-4	573	--	2.5	--	--	--	--
9L-5	572	--	3	2	--	--	--

TABLE V-1 (Continued)

SEEPAGE MEASUREMENTS

Date of Measurement (1983) -		June 29	Aug. 1	Sept. 9	Oct. 12	Nov. 8	Dec. 15
Reservoir Surface Elev. -		615.88	619.92	619.0	615.56	612.26	601.67
Seepage Monitoring[1] Location No.	Approximate Elev. (nearest 1')	Flow[2] (gpm)	Flow[2] (gpm)	Flow[2] (gpm)	Flow[2] (gpm)	Flow[2] (gpm)	Flow[2] (gpm)
8L-5	575	--	1	1	--	--	--
8L-6	575	--	3	2	--	--	--
8L-7	574	--	6	4	--	--	--
4-7	589	--	--	1	--	--	--
4-8	589	--	1.5	1	--	--	--
4L-1	589	--	12	--	--	--	--
4L-4	588	--	18	8	--	--	--
4L-5	587	--	6	3	--	--	--
4L-6	587	--	3	2	--	--	--
3-13	600	--	3	--	--	--	--
3-14	600	--	4	--	--	--	--
E-3	--	16	10	22	8	7	6
E-4	--	20	12	10	10	10	9
Total		258.5	315.5	274	218.5	132.5	87.5
Weir[3]	537	195	240	240	200	--	--
Total Panels 18, 19, 20, 21 and End Drains		153.5	116.5	127	141	101	87.5
Total Left Wall Drains		20	74.5	42	5.5	1.5	--
Total Panels 10 and 11, Right Wall Drains		89	106	107	53	24.5	--
District Weir Plunge Area[4]		--	358	--	110	180	--

NOTES:
1. See Figure V-1 for location of monitored drain holes.
2. Only drain holes with 1 gpm and greater flow were measured.
3. Weir measurements at downstream end of existing spillway are approximate.
4. See Table V-3 for District weir measurements.
5. See Figure V-2 for graph of reservoir surface elevation versus measured flows.

TABLE V-2

OBSERVATION WELL MEASUREMENTS

Date of Observation – Reservoir Surface Elev. –			Aug. 1, 83 619.92		Aug. 10, 83 621.01		Aug. 31, 83 619.07		Sept. 8, 83 619.05		Oct. 5, 83 616.24		Nov. 8, 83 612.26		Dec. 15, 83 601.67	
Observation Well No.	Elevation Reference Point	Elevation Ground Surface	Depth to Water Level (A)	Elev. of Water Level (B)	(A)	(B)	(A)	(B)	(A)	(B)	(A)	(B)	(A)	(B)	(A)	(B)
AD-1	642.0	640.5	30.1	611.9	29.2	612.8	30.4	611.6	31.5	610.5	34.6	607.4	38.1	603.9	44.1**	597.9**
AD-2	631.8	630.1	29.4	602.4	28.3	603.5	29.5	602.3	30.6	601.2	33.9	597.9	37.7	594.1	41.2**	590.6**
AD-3	594.3	591.8	10.7	583.6	10.1	584.2	10.7	583.6	11.0	583.3	14.1	580.2	15.0	574.3	20.1	574.2
AD-4	578.1	576.4	7.6	570.5	7.1	571.0	6.8	571.3	7.2	570.9	8.3	569.8	10.1	568.0	13.8	564.3
AD-5	554.0	552.5	8.5	545.5	8.7	545.3	8.4	545.6	8.4	5456	8.6	5454	9.1*	544.9	8.9	545.1

*AD-5 bailed after measurement on November 8, 1983. After bailing 3 gallons for 8 minutes, water level dropped down to 23.7. Water level rose to 21.1 2 hours after bailing.

**Within few inches of bottom of piezometer tip. May be water in bottom cap. Water level is probably below this depth and elevation.

All elevations and depth in feet.

TABLE V-3

WEIR MEASUREMENTS, SCVWD-INSTALLED WEIR AT SPILLWAY PLUNGE AREA

Date (1983)	Reservoir Elevation (feet)	V-Notch Weir Reading	Estimated Flow (gpm)
7-7	616.14	0.56	265
7-11	616.65	0.57	277
7-18	617.70	0.58	289
7-20	617.98	0.60	314
7-22	618.28	0.61	327
7-27	619.01	0.62	341
8-1	619.95	0.63	358
8-3	620.26	0.64	369
8-5	620.64	0.65	383
8-19	620.66	0.65	383
8-20	Staff gage vandalized		
9-13	Installed new staff gage		
9-14	618.40	0.55	253
9-23	617.35	0.54	242
10-3	616.37	0.53	231
10-5	616.10	0.52	220
10-14	615.13	0.51	210
10-17	614.81	0.50	200
10-31	613.21	0.50	200
11-2	612.98	0.48	180
11-4	612.71	0.47	170
11-9	612.13	0.48	180
11-14	611.76	0.47	170
11-18	611.43	0.46	162
11-28	608.15	0.45	154
11-30	607.96	0.43	137
12-2	605.59	0.41	122
12-5	604.16	0.40	115
12-7	603.85	0.38	101
12-9	603.70	0.60	314 (runoff)
12-12	603.23	0.38	115
12-16	601.03	0.37	95
12-19	599.75	0.35	83
12-21	599.59	0.34	77
12-23	599.44	0.34	77
12-26	599.75	0.35	83
12-28	598.92	0.34	77
1-4-84	595.07	0.32	66

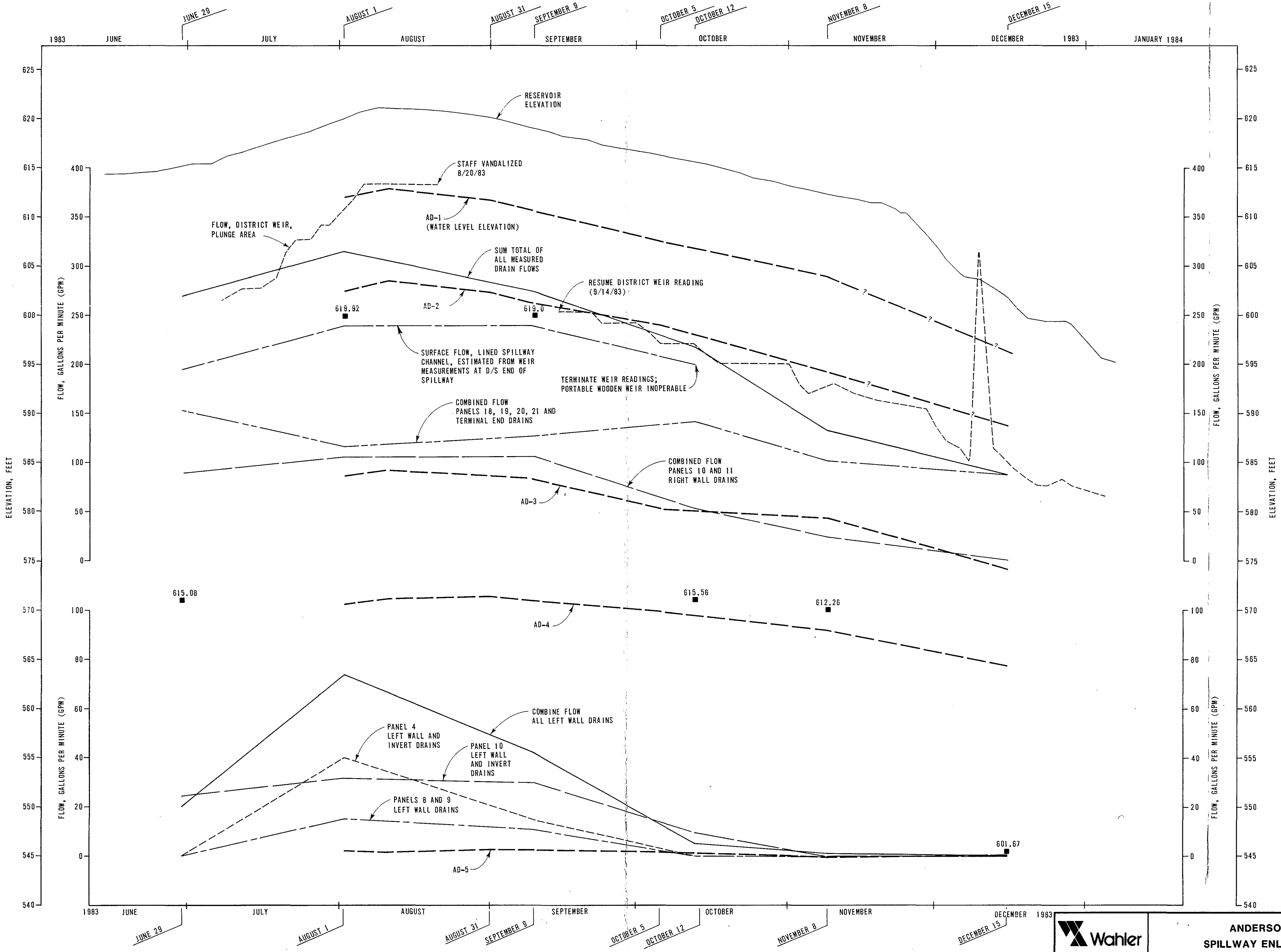
Wahler Associates

ANDERSON DAM
SPILLWAY ENLARGEMENT

PALO ALTO • NEWPORT BEACH • CALIF.

SEEPAGE AND OBSERVATION WELL MONITORING, PLAN AND PROFILE

PROJECT NO.	DATE	FIGURE NO.
SCV-124A	DECEMBER 1983	V-1



EXPLANATION

———	ANDERSON RESERVOIR WATER SURFACE ELEVATION PROVIDED BY SCVWD
— — —	WATER LEVEL ELEVATION, OBSERVATION WELLS AD-1 TO AD-5
615.56 ■	HIGHEST ELEVATION OF SEEPAGE ON LINED SPILLWAY CHANNEL; AT RESERVOIR ELEVATION SHOWN

NOTES:
1. MEASURED FLOWS ARE APPROXIMATE; ONLY FLOWS OF 1 GPM AND GREATER WERE MEASURED.
2. WATER LEVELS IN AD-1 AND AD-2 ARE PROBABLY BELOW OBSERVATION WELL TIP, DEC. 15, 1983 READING.
3. SEE FIGURE III-2 AND V-1 FOR LOCATION OF OBSERVATION WELLS AND TABLE V-2 FOR WATER LEVEL MEASUREMENTS.
4. SEE FIGURE V-1 FOR LOCATION OF DRAIN HOLES AND TABLE V-1 FOR FLOW MEASUREMENTS.
5. SEE TABLE V-3 FOR DISTRICT WEIR MEASUREMENTS.

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ANDERSON DAM
SPILLWAY ENLARGEMENT

PALO ALTO • NEWPORT BEACH • DENVER

GRAPH SHOWING RESULTS OF SEEPAGE MONITORING

PROJECT NO.	DATE	FIGURE NO.
SCV-124A	JANUARY 1984	V-2

CONSTRUCTION MATERIALS

CHAPTER VI

CONSTRUCTION MATERIALS

A. GENERAL

Other than concrete aggregate, the primary earth or rock material needs will be those required to raise the dam. Other minor volumes of material will be needed for miscellaneous backfill, drains and erosion protection. This chapter deals mainly with materials to be used in raising the dam.

Two types of material will be required to raise the dam -- earthfill to construct most of the new addition, and riprap slope protection on the upstream face. Because the reservoir would be in contact with the raised portion of the dam on only very rare occasions, and then for short periods of time, the dam fill need not be zoned. It is only necessary that the material be sufficiently impermeable to preclude excessive seepage during those temporary periods. For the same reasons, and also because there is a relatively short fetch and the materials available for construction of the new dam fill are erosion resistant, bedding beneath the riprap can be omitted.

B. DAM EMBANKMENT MATERIAL

It is estimated that the excavations required for the concrete-lined portions of the proposed spillway enlargements, as presently conceived, will generate over 30,000 cubic yards (Alternative 2) or over 50,000 cubic yards (Alternative 4). The proposed dam raise and spillway modifications will probably require about 8,000 cubic yards (Alternative 2) or 5,000 cubic yards (Alternative 4) of material in place, including structure backfill. These quantity estimates are very rough, and the various quantities should be re-computed when the design is finalized. Nevertheless, they indicate the basic situation -- there will be much more material available from the excavation than needed for dam fill and random backfill. Riprap is a separate matter, and is addressed in C, below.

A major portion of the impervious core of the existing dam was constructed using materials obtained from the spillway excavation. Based on our field and laboratory investigations, we have concluded that a sufficient quantity of suitable material can be obtained from the proposed excavation to raise the dam and dike.

Twenty-six gradation tests and 24 Atterberg limits tests were performed on materials recovered along the alignment of the proposed spillway enlargement. The test results, presented in Appendix B, indicate that the materials consist of a well-graded gravelly, clayey sand to sandy clay. The average material is composed of 15 percent gravel, 32 percent sand and 53 percent fines (fraction finer than the No. 200 sieve). The fine-grained fraction of the material exhibited high plasticity and generally plotted above the "A" line, indicating a clay consistency. The averages of all liquid limits and plasticity indices for the 24 samples tested are 62 percent and 33 percent, respectively.

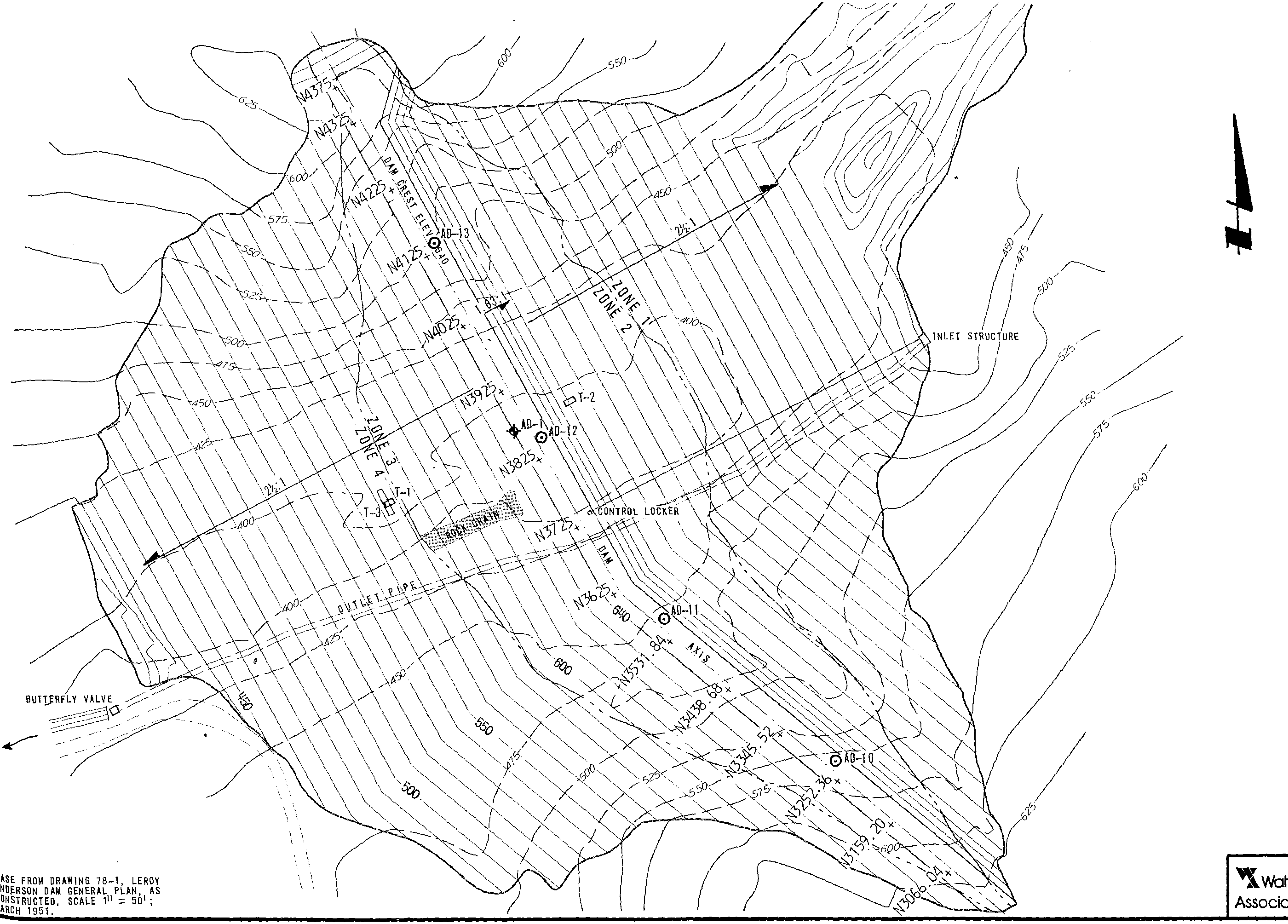
Eight of the samples tested were obtained between Stations 6+50 and 9+00 (existing spillway stationing). The average gradation of these 8 samples is almost identical to that of all 26 samples. However, the fine-grained fraction of the materials sampled from this reach exhibited intermediate, instead of high, plasticity ("average" liquid limit of 42 percent, and plasticity index of 25 percent).

From the standpoint of performance as dam material, any of the materials tested would probably be acceptable. The proposed additions to the tops of the existing dam and dike will be very low and the existing embankments and their foundations have had years to settle under much greater loads than would be exerted by the new fill. Therefore, we would not anticipate significant settlement-induced cracking of the new material, whatever its nature. However, the highly plastic material would tend to be more expansive in nature and would also be somewhat susceptible to shrinkage cracking. In addition, this material would be somewhat more difficult to work when constructing the embankment. For these reasons, we recommend that materials for use in compacted embankments be obtained from the area between Stations 6+50 and 9+00 or, if obtained elsewhere in the excavation, the materials routed to the fills be selected to have properties similar to those between the aforementioned stations.

C. RIPRAP

Because the fetch over which waves can be generated is relatively short, the riprap on the upstream face of the proposed dam fill need not be very large. Riprap on the existing dam is holding up quite well wherever the prevalent sizes are on the order of 6 to 8 inches. Therefore, we consider that a product having an average rock size of about 6 to 8 inches would be adequate, especially since exposure of this area to wave action will be so infrequent. Smaller and larger sizes should be reasonably well distributed through the masses.

The rock could be obtained from offsite commercial sources, such as those from which the District regularly purchases riprap. Alternatively, the District may elect to deepen the open discharge channel so that it can be narrowed to avoid the erosion protection problem related to the terrace deposits at its lower end, while at the same time producing rock for riprap. The greenstone in the vicinity of the man-made bluff, at the lower end of this channel, would provide suitable riprap.

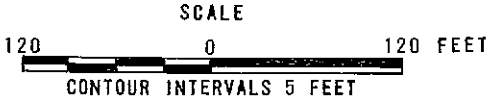


ASE FROM DRAWING 78-1, LEROY
NDERSON DAM GENERAL PLAN, AS
ONSTRUCTED, SCALE 1" = 50';
ARCH 1951.

Wahle
Associate

KEY

— — —	IMPERVIOUS CORE CONTACT OF FOUNDATION.
AD-1 ⌖	DRILL HOLE LOCATION
T-3 ▭	BULLDOZER TRENCH LOCATION
+	MONUMENT LOCATION
AD-10 ⊙	AUGER HOLE 1983



ANDERSON DAM SPILLWAY ENLARGEMENT	PLAN AND LOCATION MAP FIELD EXPLORATION		
	PROJECT NO.	DATE	FIGURE NO.
PALO ALTO • NEWPORT BEACH • CALIF.	SCV-124A	DECEMBER 1983	VI-1

ENGINEERING ANALYSES

CHAPTER VII
ENGINEERING ANALYSIS

A. GENERAL

The proposed project modifications still being considered by the District (Alternatives 2 and 4) are briefly described in Chapter I. Figures VII-1 and VII-2 (this chapter) illustrate the basic alternative project layouts for the convenience of the reader.

The proposed gated spillway (Alternative 4) will probably consist of three or four gates. Each gate would be supported at the ends. Preliminary loading information indicates that the loading from the gate structures would consist of 400 pounds per lineal foot of width, plus 13 kips at each gate support. The spillway crest would be designed to impose a uniform pressure on the supporting materials.

In both alternatives the channel bottom would be located at the same elevations as the existing channel bottom. At the end of the concrete-lined channel the water would spill onto an unlined channel. Each alternative would also require retaining structures on both sides at the beginning of the spillway. The retaining walls are estimated to be up to approximately 35 feet high.

B. STABILITY ANALYSIS

1. Sections Analyzed

The stability of the slopes above the spillway was analyzed at three locations along the approximately 850-foot reach (at Sections B-B, C-C, and D-D). Based on information provided by the District, a 13-foot deep lined channel, at a slope of 1/2 horizontal to 1 vertical, with a 10-foot wide bench at the top of the lining was used in all cases. Above the bench a slope inclination of 2H:1V was used for the majority of the investigation, while spot-checks at 1H:1V were conducted to assess the stability of oversteepened slopes in the more critical areas.

Subsequent to the bulk of the analysis, it was determined that, from the standpoint of maintenance access, a 15-foot-wide bench was more desirable than a 10-foot bench. Further analysis was then performed on the critical section (Section C-C), incorporating this change.

2. Selection of Design Parameters

A phreatic surface was inferred from water level measurements taken in the field. Shear strength parameters and other engineering properties of the soils adjacent to the spillway were evaluated based upon the results of detailed field and laboratory testing.

Static (long-term) conditions of steady seepage were analyzed using effective stress shear strength parameters. Pore water pressures were estimated as the vertical distance between the soil element of interest and the ground water table. This is referred to as a "vertical equipotential" assumption and tends to be conservative.

Seismic loading conditions were approximated by the pseudostatic method, wherein the earthquake load is represented by a destabilizing horizontal force equal to a percentage of the total weight of the soil in any given slice. This force is applied at the center of the slice. The factor of safety was calculated by using the average of the effective and total stress shear strength parameters in those portions of the slope which are below the ground water table and using effective stress parameters in those portions of the slopes that are above the water table.

3. Method of Analysis

The conventional method of limit equilibrium stability analysis using circular arc type failure surfaces formed the basis of the stability investigation. All surfaces were analyzed using both the Fellenius method of slices and Bishop's modified method. The Fellenius method is based on overall static moment equilibrium but does not consider the influence of side forces between slices. Bishop's method is a slightly more rigorous approach in which vertical equilibrium of the individual slices and overall moment equilibrium are satisfied. Side forces are included in the Bishop analysis by using the simplifying assumption that they act only in the horizontal direction.

Both these computational methods have been programmed for use on the high speed digital CDC 6600 computer. A modified version of the computer program STABR, developed at the University of California at Berkeley in 1972, was used to perform an automatic search of different potential failure arcs and to determine the most critical surface, i.e., the surface having the lowest factor of safety under the various loading conditions.

4. Results

Table VII-1 shows the material properties of all the soil types for the various conditions analyzed. The results of the analyses are shown on Table VII-2.

All of the computed factors of safety for the 2 (horizontal) to 1 (vertical) slopes, as well as those spot-checked for 1:1 slopes, were found to exceed the minimum value commonly accepted for static loading.

For the pseudostatic analyses, a maximum pseudostatic coefficient, K, of 0.2g was used. The value of K is based on evaluation of the seismicity of the site, carried out by W.A. Wahler and Associates in 1977. The analysis approximates the pseudostatic force as a static force applied at the center of the slice in the direction of instability.

The computed factors of safety are shown in Table VII-2.

In the original analysis, with a 10-foot-wide bench at the top of the spillway lining, the minimum (1.1) commonly accepted factor of safety was exceeded for a 2:1 upper slope at Sections B-B and D-D. Section C-C, however, was shown to be unstable when a seismic coefficient of 0.2g was applied. When the bench width was increased to 15 feet at Section C-C, the minimum commonly accepted factor of safety was exceeded with both 0.1g and 0.2g seismic coefficients.

5. Construction Case Analysis

In addition to the long-term stability analyses discussed above, the spillway lining slopes were analyzed for stability during construction.

The results of the analysis showed that the spillway lining slope will be stable. However, it should be noted that in this case, as in the entire analysis, it was assumed that the upper slope will be excavated prior to excavation in the spillway lining area.

C. GEOTECHNICAL PARAMETERS FOR STRUCTURAL DESIGN

1. Retaining Walls

The proposed spillway widening will require retaining walls near the ogee crest. These walls will bear on the materials below the invert of the approach channel and will have the highest top-of-wall point at Elevation 646 (Alternative 2) and 642 (Alternative 4).

Based upon the results of our field exploration and laboratory testing, parameters were developed for the design of the retaining structures. These parameters were based on the shear strength and the compressibility of the supporting soils, as well as the shear strength characteristics of the soils to be used as backfill behind the walls. Specific design parameters are presented in Chapter VIII.

2. Associated Structures

In addition to the retaining walls previously described, the proposed spillway modifications will include a new spillway weir structure, concrete walls for the channel lining, and a flood wall (Alternative 2).

The spillway weir is equivalent to a long, continuous footing, and was analyzed from the standpoint of allowable bearing capacity and settlement of the supporting materials. The concrete walls that constitute the channel lining are not considered to be retaining structures and their analyses consisted primarily of an evaluation of the foundation conditions.

The excavation of the channel will result in the removal of several feet of existing overburden material. Therefore, the structural load on the supporting soils due to the concrete lining is insignificant.

The flood wall on the dam crest for Alternative 2 will be approximately 3 feet high and will be supported probably within the materials placed to raise the dam. The wall may be supported by existing dam embankment materials or proposed compacted fill. The existing dam materials are well-compacted and the materials for the dam raise will also be well-compacted. Therefore, the flood wall will have suitable foundation support.

The pavement design for the proposed roadway along the dam crest was based on the State of California design method using the R-value of the subgrade soil. Because the pavement subgrade soils will be those soils used to raise the dam, the design R-value was based on correlations with other similar material properties.

D. EXISTING SPILLWAY STRUCTURE

The existing spillway structure was evaluated from the geotechnical standpoint. Construction drawings, photographs and other data were reviewed. Field observations of the existing structures were made.

Cracking was observed along a 200-foot length of the existing right wall, from approximately Station 4+00 to Station 6+00. The cracks are up to 1/4-inch wide and exhibit an alligator pattern within a 1 to 2-foot high strip, located about one-third of the way up the wall. Two holes, each at a different height, were cored at Station 4+51 and three holes at Station 5+41. For comparison purposes, concrete cores were taken where the cracking is most severe, and where there is no cracking. The cracks observed in the cores are only 2 to 3 inches deep and do not penetrate the entire thickness of the concrete. The cores also show that a mortar-like patch facing, about 1/2-inch thick, was placed over the original concrete facing.

Bulk samples of the soil materials behind the cores were retrieved and tested in the laboratory for classification purposes. The tests show these materials to consist of silty and clayey sands. The fine fractions of these materials have very low plasticity and swell potential.

Based on the results of this field and limited laboratory analysis, it appears that the cracking of the concrete lining is not soil-related. These results suggest that the cracking may be related to the concrete construction methods.

E. SETTLEMENT

The settlement for the proposed spillway structures and dam raise were estimated, based on the anticipated structural loading provided us by the District. The estimated settlements assume that the retaining walls and the weir structure are supported on the serpentine rock encountered in the approach channel area.

It is estimated that, for the highest wall (about 35 feet), the ultimate settlement will be approximately 2 inches. The settlement of the spillway gate foundation was estimated assuming a continuous footing imposing a uniform load on the supporting materials. One-inch of settlement is estimated for this structure.

The additional fill required to raise the dam to the desired elevations will induce additional settlement of the embankment. Data from the existing settlement movements indicates that, from construction (1950) to 1977, the maximum settlement recorded was about 1.5 percent of the embankment height. Using this figure, the proposed dam raise will induce approximately 1-inch of settlement, most of which will occur in the new fill.

TABLE VII-1

SUMMARY OF ENGINEERING PROPERTIES

Material Type	Description	Unit Weight (pcf)	Effective Strength Static Ø' (degrees)	Effective Strength Static c' (psf)	[1]Intermediate Strength Pseudostatic Ø' (degrees)	[1]Intermediate Strength Pseudostatic c' (psf)
Qf	Fill	117	35	216	--	--
Qsw_b	Slopewash	135	1	1000	--	--
Qt_1	Terrace Deposit (thin section)	111	40	1200	33	187
Qt_2	Terrace Deposit (thick section)	111	21	1224	17	1080
gw	Graywacke	117	34	360	29	360
sp	Serpentine	117	34	360	29	360

NOTE: 1. $\text{Intermediate Strength} = \dfrac{\text{Total Strength} + \text{Effective Strength}}{2}$

TABLE VII-2

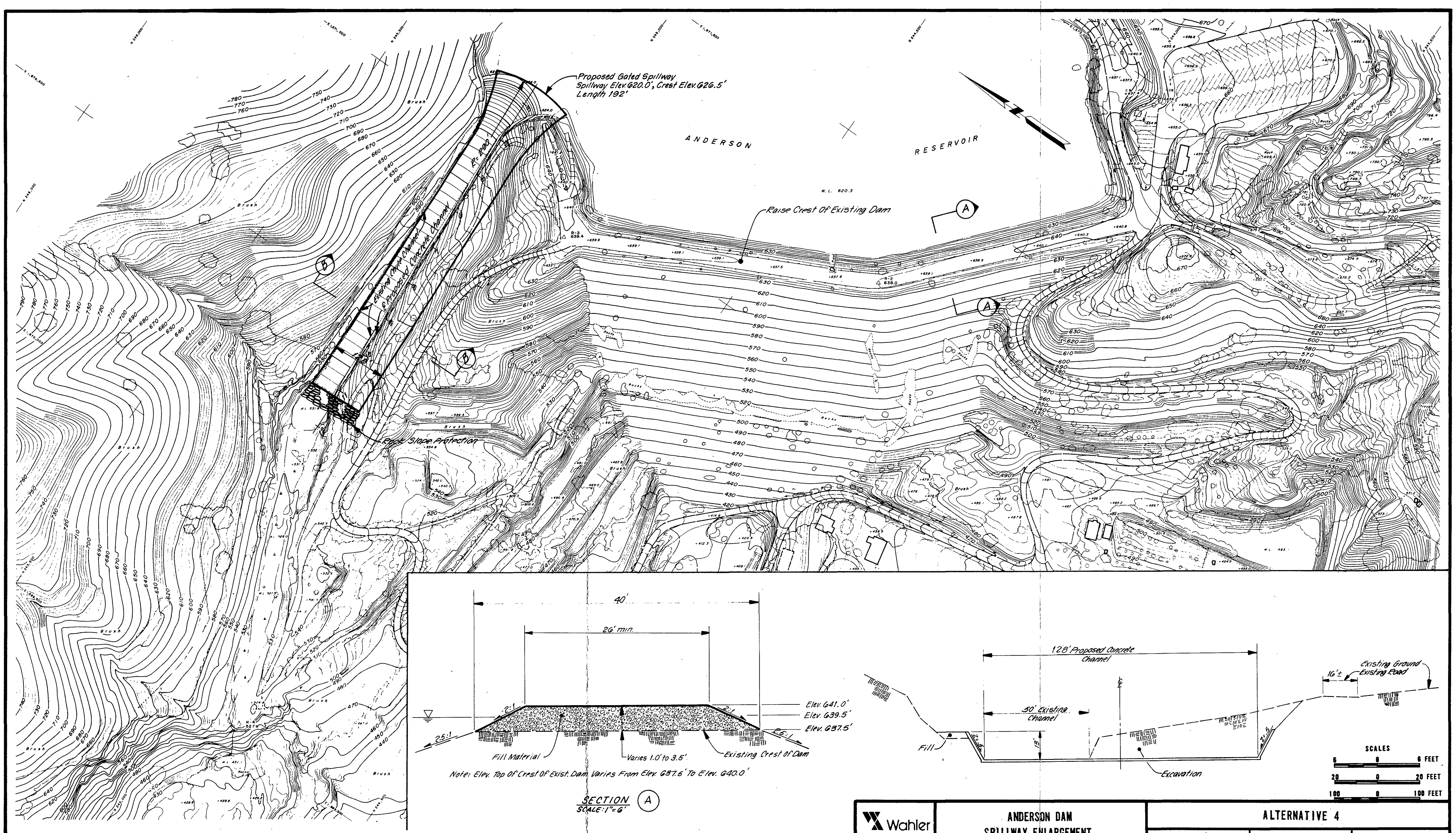
MINIMUM FACTORS OF SAFETY

Factors of Safety With a 10-foot Bench at Top of Lining and 2:1 Upper Slope

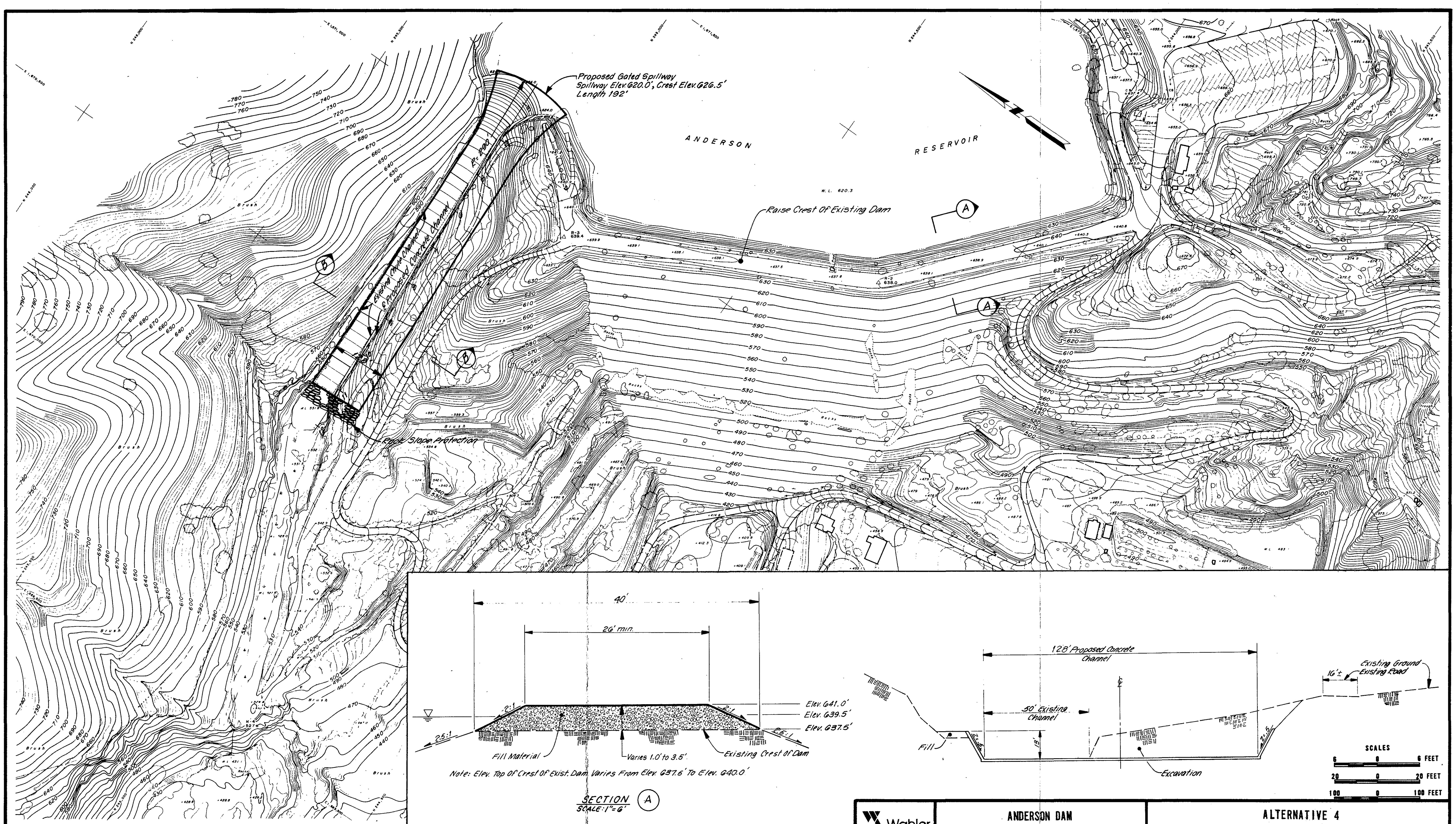
Section	Seismic Coefficient	10-foot Bench[1]		15-foot Bench	
		Alt. 2	Alt. 4	Alt. 2	Alt. 4
B-B	0 (static)	1.9	1.8	See Note 2	
	0.1g	1.4	1.4	See Note 2	
	0.2g	1.1	1.1	See Note 2	
C-C	0 (static)	1.6	2.2	1.7	2.2
	0.1g	1.1	1.6	1.3	1.9
	0.2g	0.9	1.3	1.1	1.6
D-D	0 (static)	1.9	1.9	See Note 2	
	0.1g	1.4	1.4	See Note 2	
	0.2g	1.1	1.2	See Note 2	

NOTES:

1. Width of bench at top of concrete lining.
2. Only Section C-C, considered the most critical, was reanalyzed.



Wahler Associates	ANDERSON DAM SPILLWAY ENLARGEMENT	ALTERNATIVE 4		
		PROJECT NO.	DATE	FIGURE NO.
	PALO ALTO • NEWPORT BEACH • CALIF.	SCV-124A	DECEMBER 1983	VII-2



Note: Elev. Top Of Crest Of Exist. Dam Varies From Elev. 637.5' To Elev. 640.0'

SECTION (A)
SCALE: 1"=6'

Wahler Associates

ANDERSON DAM
SPILLWAY ENLARGEMENT

PALO ALTO • NEWPORT BEACH • CALIF.

ALTERNATIVE 4

PROJECT NO.	DATE	FIGURE NO.
SCV-124A	DECEMBER 1983	VII-2

CONCLUSIONS AND RECOMMENDATIONS

CHAPTER VIII

CONCLUSIONS AND RECOMMENDATIONS

A. FOUNDATIONS

1. The proposed spillway control structure will be founded on serpentine which is typically crushed or sheared. The existing spillway control structure, which does not show any apparent foundation-related distress, is founded on this same material. The sheared serpentine should be removable by common excavation and no blasting is anticipated.

2. The lined channel will be founded on serpentine for about 20 percent of the alignment, on terrace deposit for about 30 percent of the alignment, and on graywacke, with some shale, for about 50 percent of the alignment. Light blasting could be required locally in the graywacke. It is anticipated that the finished excavation grade would be irregular in the bedrock units, more so in the less weathered rock. Overbreak of up to 12 inches is possible locally with an average overbreak on the order of 3 inches.

3. The open discharge channel will be across Franciscan rock, except for the lower end between 70 and 280 feet from the lip of the bluff, where the channel crosses terrace deposit. Blasting will be required for excavation along portions of the channel in hard bedrock.

4. Known erodible areas along the open channel are on either side of the "plunge" pool below the end of the lined channel and the terrace deposit. Other erodible areas may be exposed if the channel is widened. Protective measures should be considered in erodible areas.

B. FAULTING

1. Clear evidence for a trace of the Coyote Creek fault was found only in the approach channel area. A differently oriented fault of similar age was found in the open discharge channel. In light of the age of last movement on these faults, the likelihood of movement on these traces, sympathetic to offset on the active Calaveras fault, must be considered nil.

2. Other traces of the Coyote Creek fault could be exposed, particularly during excavation for the lined channel and the open discharge channel. These excavations should be mapped by an engineering geologist to assess any evidence for faulting, as well as record the as-built foundation conditions.

C. SEEPAGE CONDITIONS

1. There is a direct correlation of reservoir surface elevation to the zone, elevation and quantity of seepage in the proposed spillway enlargement area. Significant amounts of seepage from drain holes occur at high reservoir elevation (+619) and the highest elevation of seepage occurs near the upper end of the spillway. If construction were to be performed at high reservoir level, control of seepage and reservoir water would be extremely difficult and very costly. Our assessment of seepage conditions indicates that, at about reservoir Elevation 610, the elevation of seepage and quantity of seepage is significantly lower, and the piezometric level is below proposed invert at the toe of the proposed ogee overflow structure, and at or below proposed foundation grade for the control structure. The seepage conditions improve, of course, when the reservoir elevation is below Elevation 610. Therefore, we recommend a maximum reservoir surface elevation of 610 during spillway construction. We are of the opinion that seepage control would be manageable at this reservoir elevation.

2. In the area of the proposed excavation for the lined channel, the piezometric surface is above invert along almost the entire alignment at high reservoir (+619) elevation. At reservoir Elevation 612, the piezometric surface is also above invert, except for the control structure area. This indicates that seepage may be bypassing the lined spillway drains and that the total seepage is probably higher than measured from the drain holes.

3. Reservoir leakage will continue to occur in the spillway area during the operation of the reservoir and could be quite significant at high reservoir elevation. Therefore, generous subdrain provisions should be included during design beneath the slab, behind the walls and along the left side of the proposed spillway. The subdrain system discussed in Chapter V, and later in this chapter, can be tied into the existing subdrains beneath the existing spillway floor slabs. Because this new subdrain system will intercept much of the seepage now occurring to the left side of the existing spillway, and because the existing system appears to be effective in controlling hydrostatic pressures on the existing spillway, we see no need to install additional subdrains beneath portions of the floor slabs or right wall which will not be removed during spillway enlargement.

D. CONSTRUCTION MATERIALS

1. Sufficient earth materials of adequate quality to construct the dam and dike raise, and for random backfill, can be obtained from the proposed excavations for either alternative spillway enlargement. The most suitable material for those purposes generally appears to occur in the reach between approximately Stations 6+50 and 9+00 (existing spillway stationing).

2. Riprap could be obtained from the greenstone rock at the lower end of the open discharge channel, or from commercial sources, at the District's option.

E. GEOTECHNICAL DESIGN CRITERIA

1. Spillway Modifications

a. Spillway Chute

Based on the results of our study we conclude that, from a geotechnical standpoint, the existing spillway structure and underdrain system can be incorporated into the enlarged spillway scheme. Due to hydraulic design requirements, the existing spillway chute will be removed from the approach channel to approximately Station 5+00.

Spillway Weir Structure - We recommend that the spillway weir structure be founded a minimum of 4 feet below the lowest adjacent finished grade, which for both alternatives will be the approach channel elevation, or on suitable rock, whichever is lower. Because the approach channel elevation (615) for Alternative 4 is lower than for Alternative 2 (620), we anticipate that no additional penetration in rock will be necessary for Alternative 4. At this level, the weir structure may be designed for an allowable bearing pressure of 3,000 psf. Estimated foundation settlements corresponding to this bearing pressure are anticipated to be less than 1-inch.

Because of the grade differential upstream and downstream of the spillway weir, the weir acts as a retaining structure. Design criteria for retaining structures are given in Table VIII-1 at the end of this chapter. The passive resistance of the material downstream of the weir is also shown in Table VIII-1.

Chute Floor - The proposed spillway chute floor will consist of a reinforced concrete slab. From a structural support standpoint, the materials encountered at invert level are considered adequate for slab support. Because of the necessary excavation, the new loads imposed by the slab will be less than the weight of the overburden removed.

Loading of the slab will develop by hydrostatic uplift forces acting at the bottom of the slab. To reduce uplift forces acting on the slab, it is recommended that a system of drains be installed beneath the slab.

As a minimum, we recommend that transverse drains be installed every 30 feet or less. Longitudinal drains should be installed along the joint of the old and new slabs and along the left edge of the new slabs. These drains should be at least 2 feet deep and constructed with a permeable filter material. As in the existing spillway, the drains should daylight onto the slab and should include provisions for cleanout. We recommend that Class I Type B (Section 68-1.025, 1981 Caltrans Standard Specifications) material be used for permeable material surrounding the subsurface drains. Perforated metal pipe, with a minimum diameter of 6 inches, should be placed in the subsurface drains.

We recommend that a continuous drainage blanket be placed beneath the slab from Station 9+00 to the end. The blanket should be at least 12 inches thick and should consist of Class I, Type B drain rock, suitably compacted.

Cutoff - The cutoff structure at the end of the lined channel should be embedded at least 4 feet below the lowest adjacent grade. This area should be protected with riprap to control erosion and undermining of the footing.

The design criteria given for the spillway weir may be used in the design of this structure. We recommend that riprap be placed downstream of this structure to minimize erosion.

Chute Wall Lining - The new left sidewall will consist of a reinforced concrete lining for the entire length of the chute. At and near the spillway weir, the lining will consist of retaining walls.

The recommended inclination of the slopes behind the lining reflects the non-structural nature of the lining. To prevent the build-up of hydrostatic pressure, the channel lining should include weep holes at or near the base and at an intermediate level.

The existing wall lining along the right side will be raised approximately 3 feet. It is proposed to also raise the elevation of the bench adjacent to the lining. We recommend that the grading and earthwork be done is accordance with the recommendations for the dam raise (given later). However, only small equipment (i.e., hand-held compaction equipment) should be allowed to operate in this area. Large equipment could induce high pressures on the existing lining which it is not designed to resist.

The retaining walls for the spillway entrance will be approximately 30 feet high. We recommend that the walls be founded a minimum of 4 feet below the lowest adjacent finished grade, or on suitable rock, whichever is lower. Walls bearing on the recommended material may be designed for a maximum allowable pressure of 5,000 psf. The allowable bearing pressure given for the walls is higher than the bearing pressure given the weir structure. This difference reflects our understanding that the retaining walls will have a larger base and flatter adjacent ground than the weir structure. Estimated footing settlements corresponding to this bearing pressure are anticipated to be less than 2 inches. The recommended lateral earth pressures are summarized in Table VIII-1 at the end of this chapter. Table VIII-1 also includes design values for the resistance of lateral loads.

The walls will experience additional lateral earth pressures during an earthquake. This pressure is a function of the maximum ground surface acceleration and should be assumed to act uniformly over the entire height of the wall. There are several methods available to calculate these additional lateral pressures. Two methods are described in a paper by Seed and Whitman (1970), the Mononabe-Okabe seismic coefficient analysis and lateral pressure analysis by Matsuo and O'Hara. In addition, the California Department of Water Resources (1966) has used a variation.

Based on the estimated seismicity of the site, it is our recommendation that the additional lateral pressure caused by earthquake shaking be estimated with the following relationship, using the Mononabe-Okabe analysis:

$$\Delta P = 31H$$

where: ΔP = uniform horizontal lateral earth pressure in psf.
H = height of wall in feet.

The lateral pressures given in Table VIII-1 are for a drained condition; therefore, the walls should be designed with adequate drainage facilities to prevent the buildup of water pressure behind the walls.

We recommend that granular backfill, at least 1-foot thick, be placed behind the wall. This material should be compacted to approximately 95 percent of the laboratory maximum dry density, as determined by ASTM D2049-69. Native material can be used to backfill the excavation beyond these limits, provided it is compacted to at least 95 percent of the maximum laboratory density as described in Section 2a, later in this chapter. The granular backfill should consist of Class I, Type B drain rock. Weep holes at several levels should also be included in the walls.

Slopes Above Chute Wall Lining - Construction of the left side of the spillway will require the regrading of the area above the proposed chute wall lining. Based on the results of the slope stability analyses, discussed in Chapter VII, we recommend that the slopes above the chute walls be graded no steeper than 2 horizontal to 1 vertical.

The recommended slopes will encroach on the existing access roadway. Therefore, it will be necessary to relocate a portion of the road. Because of the wider channel, Alternative 4 will require a longer roadway relocation than Alternative 2. The topography south of the existing road suggests that the road could be relocated south of its present alignment with a minimum of regrading.

If for any reason the road cannot be relocated, retaining walls could be built along the edge of the road. These retaining walls would make it possible to grade the slopes to the recommended inclinations.

b. Discharge Channel

The spillway chute will discharge into an open, unlined channel. Depending on the depth and the width of the open channel, the bottom and left side may be either rock or terrace deposits. Because of the existing topography, and in order to control the flow and erosion, the channel would need to be deepened towards the end.

Erosion and slope stability are areas of concern with regard to the open channel. The terrace deposits are easily eroded. Therefore, we recommend that the slope inclinations within the terrace materials be 2:1 (H:V) or flatter and that, where these materials are part of the channel, they be protected, as a minimum with riprap. A more preferable slope protection could be achieved with the use of gabions. However, gabions are more expensive than riprap and their use should be evaluated from the standpoint of channel velocities and anticipated channel maintenance programs.

The portions of the slopes within the rock formations may be inclined at 1 to 1 or flatter. Although some erosion may occur and some maintenance will be needed, no permanent protection measures are deemed necessary. Specific areas should be reviewed during construction for possible localized treatment.

Overall, we recommend that the channel be deepened as a preferred alternative. A deeper channel would avoid water flowing within the weaker deposits, would avoid the problems with the existing topography near the end of the channel, and it would provide a source for the riprap material needed for the dam raise and other erosion protection.

2. Dam Raise

The dam will be raised by placing additional compacted fill on the existing crest. The dike between the right abutment and the spillway will also be raised by placing compacted fill.

a. Stripping and Excavating

In preparing the top of the dam for the support of the new embankment, the existing roadway section should be stripped and removed. Beyond the paved areas, as on the adjacent dike, the surface vegetation and contaminated soil should also be stripped and removed. Based on our exploration and observations at the site, it is estimated that the required stripping will be on the order of 6 inches in the roadway area. The depth of stripping in the non-paved area is estimated is estimated to be about 3 inches. After stripping, the exposed surface should be scarified and compacted to a minimum relative compaction of 95 percent of the laboratory maximum dry density as determined by ASTM Test Designation D1557-78 modified to 20,000 foot-pounds per cubic foot of compactive energy.

b. Embankment Materials

It is recommended that materials from the spillway excavation be used to raise the dam. Because of their lower plasticity, it is recommended that the materials from approximately Station 6+50 to Station 9+00 be used in the embankment. The embankment materials should be compacted to a minimum relative compaction of 95 percent, as previously described, and at a moisture content of within 2 percent of the laboratory optimum moisture content. We anticipate that moisture conditioning of the embankment materials will be necessary, based on the moisture contents of the recommended borrow materials.

The embankment materials should be placed in layers not exceeding 8 inches before compaction.

To minimize the probability of erosion, the embankment faces should be properly treated. We recommend that proper compaction of the slope faces be achieved by constructing the embankment approximately 2 feet (horizontally) beyond the planned final face plane. The embankment face could then be trimmed back to the final face plane. This operation should expose properly compacted material on the finished face of the embankment.

The upstream slope should be protected with a layer of riprap. This layer should have a minimum thickness of 12 inches (measured perpendicular to the embankment face) and should consist of rock having an average size of between 6 and 8 inches (minimum dimension), with smaller and larger sizes reasonably distributed throughout the mass.

c. Maintenance Road Pavement

Based on their plasticity and gradation characteristics, we estimate the R-value of the proposed embankment soils to be approximately 10. Therefore, an R-value of 10 is recommended, and was used for design purposes.

Recommended pavement section thicknesses are summarized in Table VIII-2. Three traffic indices were assumed in the design. Pavement sections corresponding to traffic indices differing from those shown can be provided upon request.

All pavement construction and materials used should conform to applicable sections of the latest edition of the Caltrans

Specifications, State of California, Department of Transportation. The top 6 inches of subgrade beneath the pavements should be stabilized and compacted to a minimum relative compaction of 95 percent, based on California Test Method 216.

d. Protection of Existing Monitoring Instruments

After construction of Anderson Dam, fifteen surface monuments and two pneumatic piezometers were installed, more or less uniformly, along the crest. The surface monuments consist of either 1-inch-diameter bars or a nail and pin. The piezometers were installed in one exploratory hole drilled during the performance evaluation of the dam in 1977. These monitoring devices provide valuable data in the continuing evaluation of the dam's performance, and must, therefore, be protected during the construction activities along the crest of the dam.

There are a number of ways to protect these monuments. For the surface monuments, we suggest a new plate with a vertical pipe. These plates can be installed easily on top of the existing monuments and can be protected during construction. The plates can be welded to a riser pipe which then becomes the new monument. The top of the new pipe can be set a few inches below the top of the road and protected with a locking device.

The piezometers can be extended by coupling an extension to the existing leads as needed, and providing a protective assembly around the leads. The coupling and lead extension can be obtained from the manufacturer and can be easily installed in the field. The piezometers are the pneumatic type and are manufactured by SINCO (Seattle). Protection of all monuments during construction should be the responsibility of the contractor.

e. Floodwall

The floodwall proposed for Alternative 2, will be 3 feet high. The wall will be supported on the new embankment fill. The only long-term structural load imposed on the supporting soils is the dead weight of the wall. The compacted fill will support this load without undergoing significant differential settlements. However, because of the plasticity of the soils prepared to raise the dam, some shrink/swell of the supporting soils may occur within the life of the structure. Therefore, we recommend that the bottom of the wall be positioned at an elevation no higher than 2 feet below the new top of the dam, where fluctuations in the moisture content of the supporting soils are less likely to occur.

We recommend that some steel reinforcement be included in the wall to help bridge localized areas where differential settlement or swell may develop due to variations in the type of supporting soils.

From a geotechnical standpoint, the proposed floodwall does not present any particular problems, and because of the nominal water head it is our opinion that no special design provisions are needed. Although only minor differential movements are anticipated between the wall panels, we recommend that effective water stops be included between the individual wall panels. These water stops can be the type commonly used in similar structures and no special design is deemed necessary.

3. Construction Considerations

a. Temporary Slopes

It is recommended that, except for the planned chute wall slopes, temporary unsurcharged slopes not exceed an inclination of 1 horizontal to 1 vertical. The slopes should be continuously monitored for possible signs of instability. It is recommended that the slopes be flattened as required in areas observed to be potentially unstable. The contractor should provide for protection of any workers in the excavation during placement and backfilling, in accordance with the State of California, Division of Industrial Safety requirements. The construction methods and sequence should be such that they do not endanger or otherwise adversely affect the stability of slopes.

We recommend that the excavation and regrading of the slopes above the channel lining be done before the channel is excavated in order to increase the slope stability during construction.

b. Drainage

The deep trench to be located on the maintenance bench should also be installed prior to the channel excavation. As discussed elsewhere in this report, and depending on the reservoir elevation at the time of construction, this subdrain would be useful in lowering the ground water level near the new channel slope. Besides providing additional stability, it should intercept water seepage.

This subdrain, however, may not be sufficient to handle all the seepage during construction. In addition, it is recommended that sumps and pumps be used in localized areas. We recommend that, where possible, the water seepage and flow discharge be directed to the existing lined channel.

c. Reservoir Level

Besides affecting the conditions in the spillway area, the reservoir level will be a major consideration in the construction of the structures near the approach channel. If the reservoir level is above approximately elevation 610, it is likely that dewatering may be necessary in the area of the approach walls and weir structure. In the area adjacent to the reservoir, a cofferdam or similar structure may be necessary to construct the retaining structures.

d. Blasting

It may be necessary to blast some of the rock encountered along the proposed alignment of the chute. Should blasting become necessary, it is recommended that the existing spillway channel, which is to remain, be protected. This may be achieved by precutting the concrete along predetermined sections outside the areas to be integrated with the new structure.

e. Concrete Lining Repairs

Our assessment of the right side lining does not indicate a severe structural failure. However, the cracked areas should be re-patched. We recommend that the grout-type material, which was placed after construction, be removed and replaced with new concrete, properly keyed into the lining beneath.

TABLE VIII-1

DESIGN RECOMMENDATIONS FOR RETAINING WALLS

Type of Wall	Maximum Slope of Backfill	Minimum Equivalent Fluid Pressure[1] (pcf)	Maximum Allowable Bearing Capacity[2] (pcf)		Passive Resistance of base key (Equivalent Fluid Pressure) (pcf)		Minimum Footing Embedment (ft)	Friction Coefficient Along Base
			Spillway Weir, Cutoff	Spillway Entrance Walls	Spillway Weir, Cutoff	Spillway Entrance Walls		
yielding	flat	40	3,000	5,000	300	400	4	0.5
unyielding	flat	55	3,000	5,000	300	400	4	0.5
yielding	3:1	40	3,000	5,000	300	400	4	0.5
unyielding	3:1	60	3,000	5,000	300	400	4	0.5
yielding	2:1	55	3,000	5,000	300	400	4	0.5
unyielding	2:1	75	3,000	5,000	300	400	4	0.5

[1] Pressures shown do not include hydrostatic pressures, and assume a drained condition.

[2] These values may be increased by 1/3 for temporary loading.

TABLE VIII-2

PAVEMENT DESIGN

Traffic Index	Alternate Sections	Asphaltic Concrete (inches)	Class II[1] Aggregate Base (inches)
4	A	2.0	8.0
	B	3.0	6.0
5	A	2.0	11.0
	B	3.0	9.0
6	A	3.0	12.0
	B	4.0	10.0

NOTE: All layers in compacted thickness

[1] Caltrans Standard Specifications (1981)

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REFERENCES

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APPENDIX A

APPENDIX A

FIELD INVESTIGATION

The field investigation was performed during the spring and summer of 1983 and included geologic mapping, seismic refraction surveys, excavation and logging of exploration trenches and test pits, auger and rotary wash drilling, piezometer installation, field density testing, seepage monitoring, and concrete coring.

A. GEOLOGIC MAPPING

Geologic mapping for this investigation consisted of detailed mapping of the approach channel and spillway channel enlargement areas. The purpose of the detailed mapping was to provide a basis for correlating surface and subsurface geologic data so that a reasonable interpretation of foundation conditions could be developed. Among the concerns of the investigation were the determination of whether traces of the Coyote Creek fault pass through the spillway area (and therefore, possibly through the dam foundation) and the age of such faulting.

The geologic mapping in the approach channel began June 16, 1983 and was the initial exploration phase of this investigation. Mapping, as well as the subsurface work in the approach channel, was performed on an expedited basis to take advantage of the temporarily lowered reservoir and to complete the work before the planned raising of the water level.

The geologic mapping in the approach channel was done at a scale of 1:240 on an enlarged topographic base provided by the District. A thin veneer of surficial materials covered much of the flat area behind the spillway crest and mapping was restricted to the cutslopes on the north side of the channel and to the steeper slopes at the upstream margin of the approach area. The mapping was enhanced by excavation of backhoe trenches and by removal of slopewash from portions of the north cutslope with a backhoe. The approach channel geology is shown on Figure III-1.

Geologic mapping of the area along the spillway channel enlargement area began June 23, 1983, and continued intermittently through August 11, 1983. The mapping was done at a scale of 1:600 on a topographic base provided by the District. Locally thick vegetation and large areas of fill obscured geologic evidence. The mapping was performed along the proximate north side of both the lined channel and the open discharge channel and 300 feet south of the lined channel. Figure III-2 shows the geology and exploration along the spillway channel areas.

B. SEISMIC REFRACTION SURVEY

Eleven seismic refraction survey lines were run to determine seismic velocities in the materials underlying the site. The seismic velocities were used to assist in evaluating foundation conditions, in particular, depth to bedrock and excavatability. The work was done July 7 and 8, 1983. A Bison model 1570-C Signal Enhancement Seismograph with a single geophone was used; a 10-pound sledge striking a metal plate provided the energy input. The results of this work are incorporated in this appendix.

C. EXPLORATION TRENCHES AND TEST PITS

Twenty-one exploration trenches were excavated primarily to study geologic conditions at the site (the log for Trench T-8 was obtained by logging a hand-cleaned cutslope in the approach channel). A secondary goal of these trenches was to assess for potential borrow. Ten of the exploration trenches (T-1 through T-9 and including T-8) were located in the approach channel and these are shown on Figure III-1. Twelve trenches (T-10 through

T-22) were located south of the spillway channel and these are shown on Figure III-2. Exploration trench logs are included in a subsection to this appendix.

The trenches were excavated with a JD-450 backhoe to depths varying from 18 inches to 13 feet. Shoring was used in trenches deeper than 5 feet. Diganics Inc., furnished the backhoe, operator, and shoring under a subcontract to Wahler Associates. Work on the exploration trenches was performed between June 20, 1983 and August 11, 1983. During excavation of Trench T-14, the backhoe severed a drain installed to dewater the area south of the spillway. The damaged perforated pipe was replaced and covered with gravel/sand drain material prior to backfilling the trench.

A total of twenty-four exploration pits were dug. The primary purpose for this work was to assess materials at the site for potential as borrow to use in raising the dam. A secondary function was to assess geologic conditions in the area. Five of the pits (TP-20 through TP-24) were dug primarily to obtain in-situ moistures and densities. The test pits were located south of the spillway channel and are shown on Figure III-2. Descriptive test pit logs are included in a subsection to this appendix.

The test pits were excavated with a JD-450 backhoe furnished by Diganics Inc., under a subcontract to Wahler Associates. The test pits were dug typically to about 12 feet, except that the five density-test pits (TP-20 through TP-24) were dug to 5 or 6 feet. Shoring was used only in the density-test pits; the other test pits were not entered. Except for the density-test pits, the work was performed between July 13 and 18, 1983. The density-test pits were dug and sampled August 10, 1983.

Both the exploration trenches and the test pits encountered significant thickness of fill in certain areas of the work. The fill was apparently spoil from the construction of the dam. The areal extent of this fill is shown on Figure III-2.

D. AUGER AND ROTARY WASH DRILLING

Eight auger holes were drilled in this investigation. Four auger holes, AD-6 through AD-9, were drilled to evaluate the geology at and near the proposed channel invert; some samples were obtained to supplement those taken earlier in the rotary wash holes. Auger holes AD-10 through AD-13 were drilled along the crest of the dam to sample the dam materials beneath the roadway for an evaluation of compatability with potential borrow materials. The locations of holes AD-6 through AD-9 are shown on Figure III-2; the locations of holes AD-10 through AD-13 are shown on Figure VI-1. The auger drilling was performed by Weyer Drilling under a subcontract to Wahler Associates on August 9 and 12, 1983. Logs for the auger holes are included in a subsection to this appendix.

Five rotary wash holes (AD-1 through AD-5) were drilled in the area of the proposed enlargement. The holes were drilled to obtain samples for laboratory testing, to assess geologic conditions, and to allow for installation of piezometers. The locations of these holes are shown on Figure III-2. The holes were drilled between July 18, and July 25, 1983 by Failing Drill Company under a subcontract with Wahler Associates. Logs for the rotary wash holes are included in a subsection of this appendix.

E. PIEZOMETER INSTALLATION

Five open-well piezometers were installed to determine the piezometric surface along the proposed spillway enlargement area. The piezometers were installed (one each) in rotary wash borings AD-1 through AD-5, which were drilled using a degradable type of drill fluid. The locations of the piezometers are shown on Figure III-2. The piezometers consist of a 2-inch Schedule 40 PVC pipe with a slotted tip. Sand backfill was placed around each tip to allow water access from the zone of interest. A bentonite plug was placed above the sand. Native backfill (clayey soil) was used to fill the hole above the bentonite plug. A 4-inch diameter steel casing with a locking protective cover was installed at each piezometer. Pertinent data are included on the Piezometer Data Sheets provided by the District and included in a subsection of this appendix.

F. FIELD DENSITY TESTS

Eight field density tests were performed using ASTM Method D1556-64 (sand cone). The tests were taken at depths of 2 to 6 feet in test pits TP-20 through TP-24. The locations of these test pits are shown on Figure III-2. The purpose of the field density testing was to ascertain in-situ densities and moistures for evaluation of potential borrow materials. The results of the field density testing are summarized in a subsection of this appendix.

G. SEEPAGE MONITORING

A seepage monitoring program was conducted to evaluate the effects of changing reservoir levels on seepage in the spillway area.

The drain holes in the existing lined spillway channel were monitored on a monthly basis from June to December, 1983, to measure the amount of flow passing out from these holes. Measurements were performed by inserting a plastic hose or pipe snugly into the drain hole and measuring the flow in a calibrated container. In addition, a portable wooden weir was installed at the terminal end of the spillway to estimate total flow, however, these weir measurements were discontinued after 3 readings because of damage to the weir. The locations of the drain holes are shown on Figure V-1. The results of the seepage monitoring are discussed in Chapter V.

H. CONCRETE CORING

Five 4-inch core holes were drilled in the right (north) wall of the lined channel to investigate cracks and an apparent bulging in the wall. Two holes were drilled opposite Station 4+51 at slope heights of 2.2 and 6.5 feet. The three holes were drilled opposite Station 5+41 at slope heights of 1.5, 4.2, and 6.5 feet. The location of these concrete core holes is shown on Figure III-2. The holes were drilled through the concrete with an electrically driven Diamond Products concrete coring machine by Cal-West Inc., under subcontract to Wahler Associates. The holes were deepened (beyond the concrete) by hand auger and hand driven sampling devices to sample the materials behind the concrete. Two of the holes (5-1 and 7-1) were backfilled with mortar. A length of 3/4-inch Schedule 40 PVC pipe was installed in each of three remaining holes (5-2, 7-2, and 7-3) as a drain which had its lower end slotted. The pipe was placed in the hole with an end-cap, sand backfill was placed up to the back of the concrete. A burlap filter was placed in the hole to protect the sand. The hole was then filled with mortar. Logs of the concrete core holes are included in a subsection of this appendix.

SEISMIC REFRACTION DATA
SUMMARY SHEETS

LOCATION SEE FIGURE III-2

LINE NO. SL-1

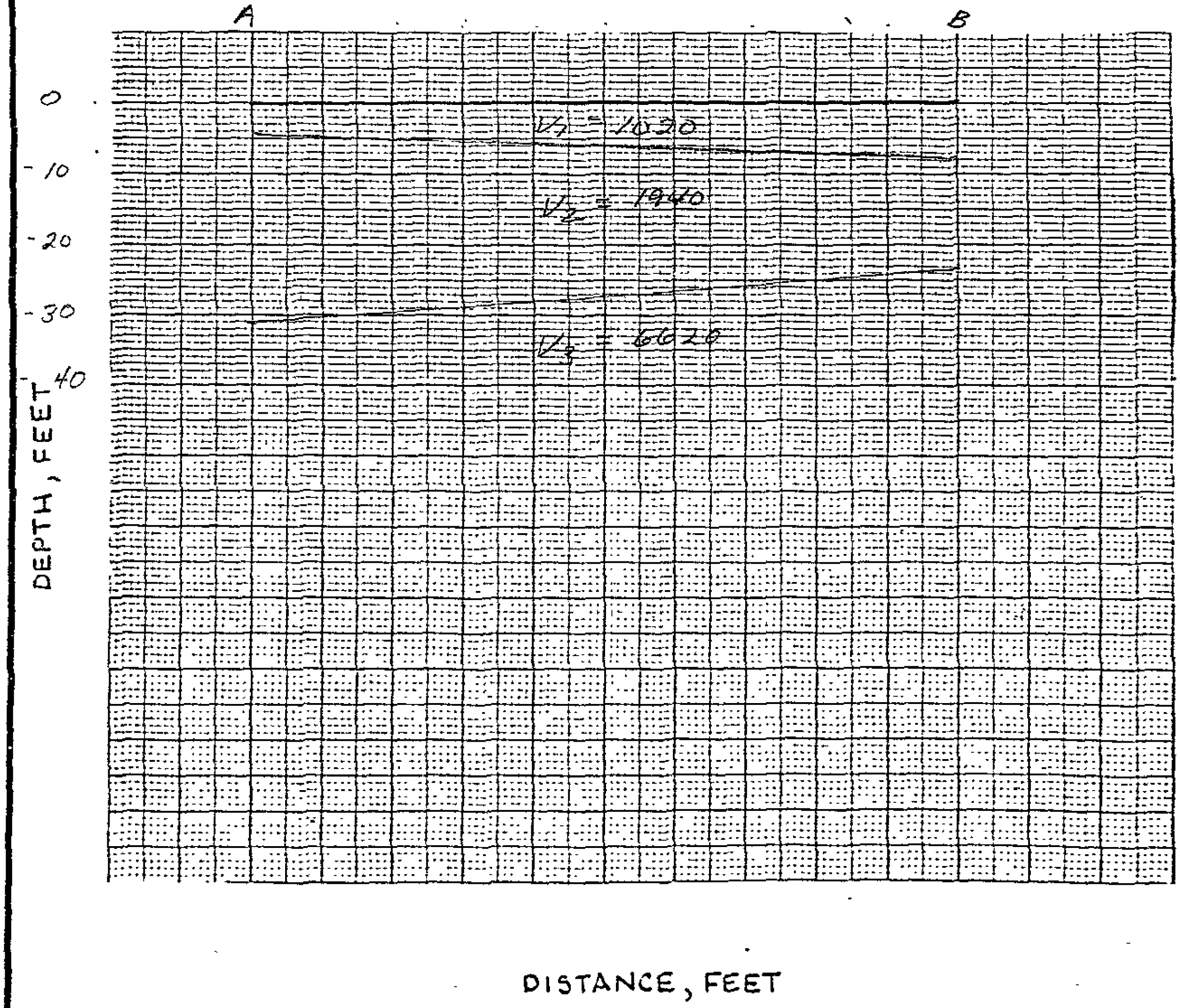
LINE BEARING (A TO B) S 43°W

PERFORMED BY ES

LINE LENGTH 100'

DATE 7/7/83

V_1		1020
W_2	DIP ANGLE	-2.44
V_2		1940
HA_1	THICKNESS	4.3
HB_1	THICKNESS	7.6
W_3	DIP ANGLE	4.71
V_3		6620
HA_2	THICKNESS	31.0
HB_2	THICKNESS	23.5



Wahler Associates PALO ALTO • NEWPORT BEACH • DENVER	ANDERSON DAM SPILLWAY ENLARGEMENT	SEISMIC REFRACTION DATA SUMMARY SHEET

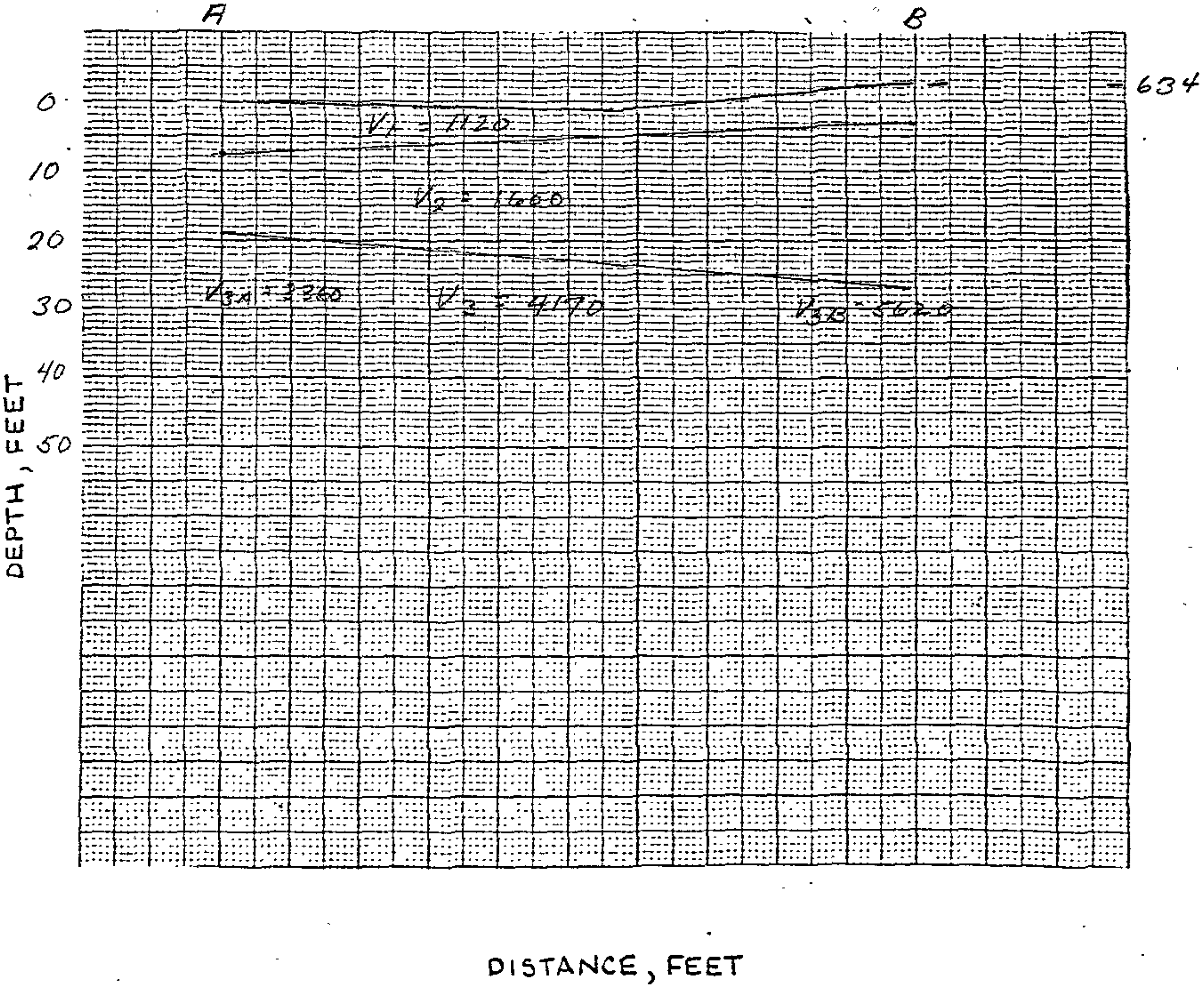
PROJECT NO.	DATE	SHEET NO.
SCV-124A		1 OF 1

LOCATION SEE FIGURE III-2 LINE NO. SL-2

LINE BEARING (A TO B) S60°W PERFORMED BY ES

LINE LENGTH 100' DATE 7/7/83

V_1	1120
W_2	1.41
V_2	1600
HA_1	7.9
HB_1	5.6
W_3	-6.64
V_3	4170
HA_2	10.8
HB_2	23.9



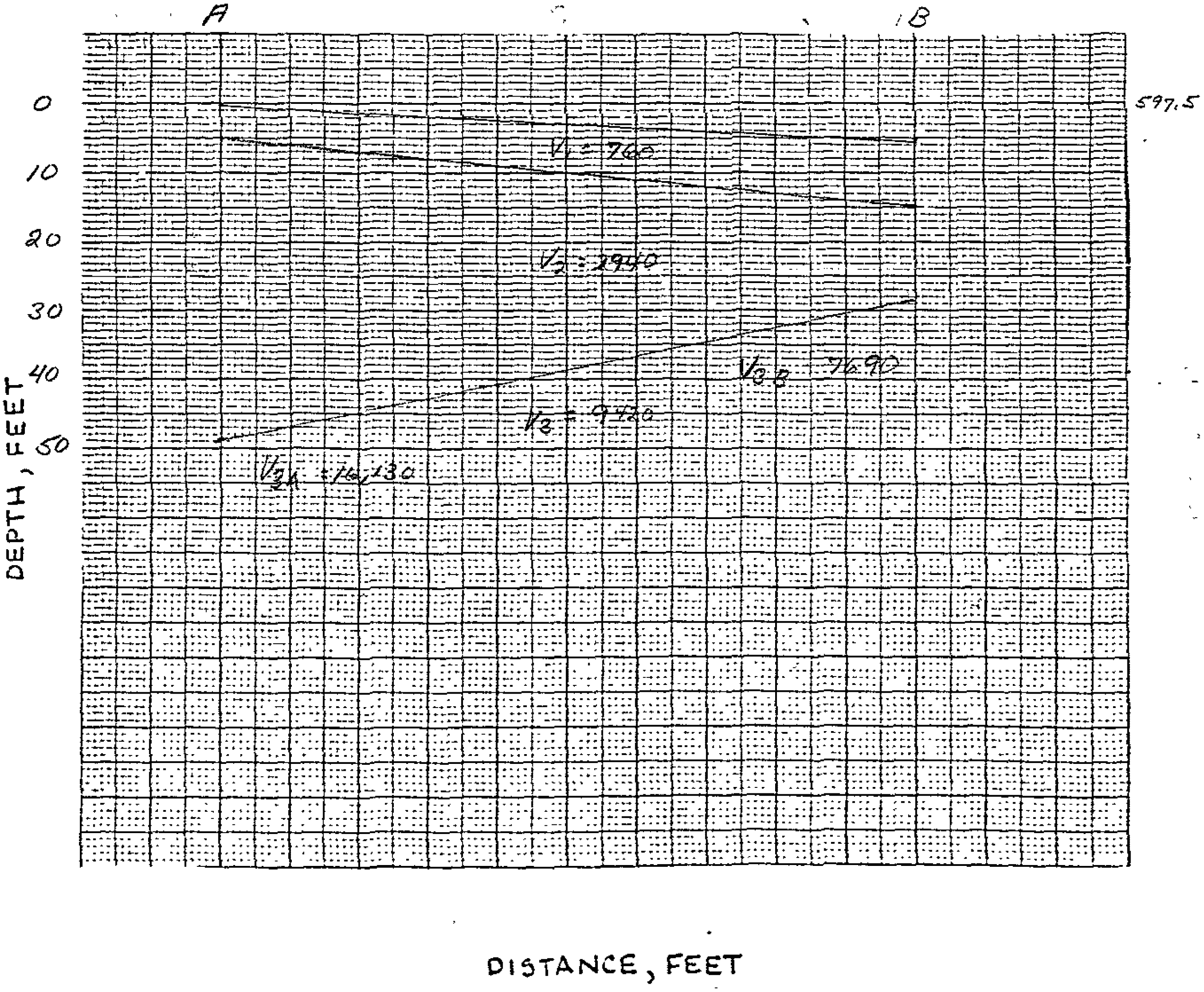
Wahler Associates	ANDERSON DAM SPILLWAY ENLARGEMENT	SEISMIC REFRACTION DATA SUMMARY SHEET	
PALO ALTO • NEWPORT BEACH • DENVER	PROJECT NO. SCV-124A	DATE	SHEET NO. 1 OF 1

LOCATION SEE FIGURE III -2 LINE NO. SL-3

LINE BEARING (A TO B) S80°W PERFORMED BY ES

LINE LENGTH 100' DATE 7/7/83

V_1	760
W_2	-4.69
V_2	2940
HA_1	5.0
HB_1	9.4
W_3	21.24
V_3	9420
HA_2	440
HB_2	13.4



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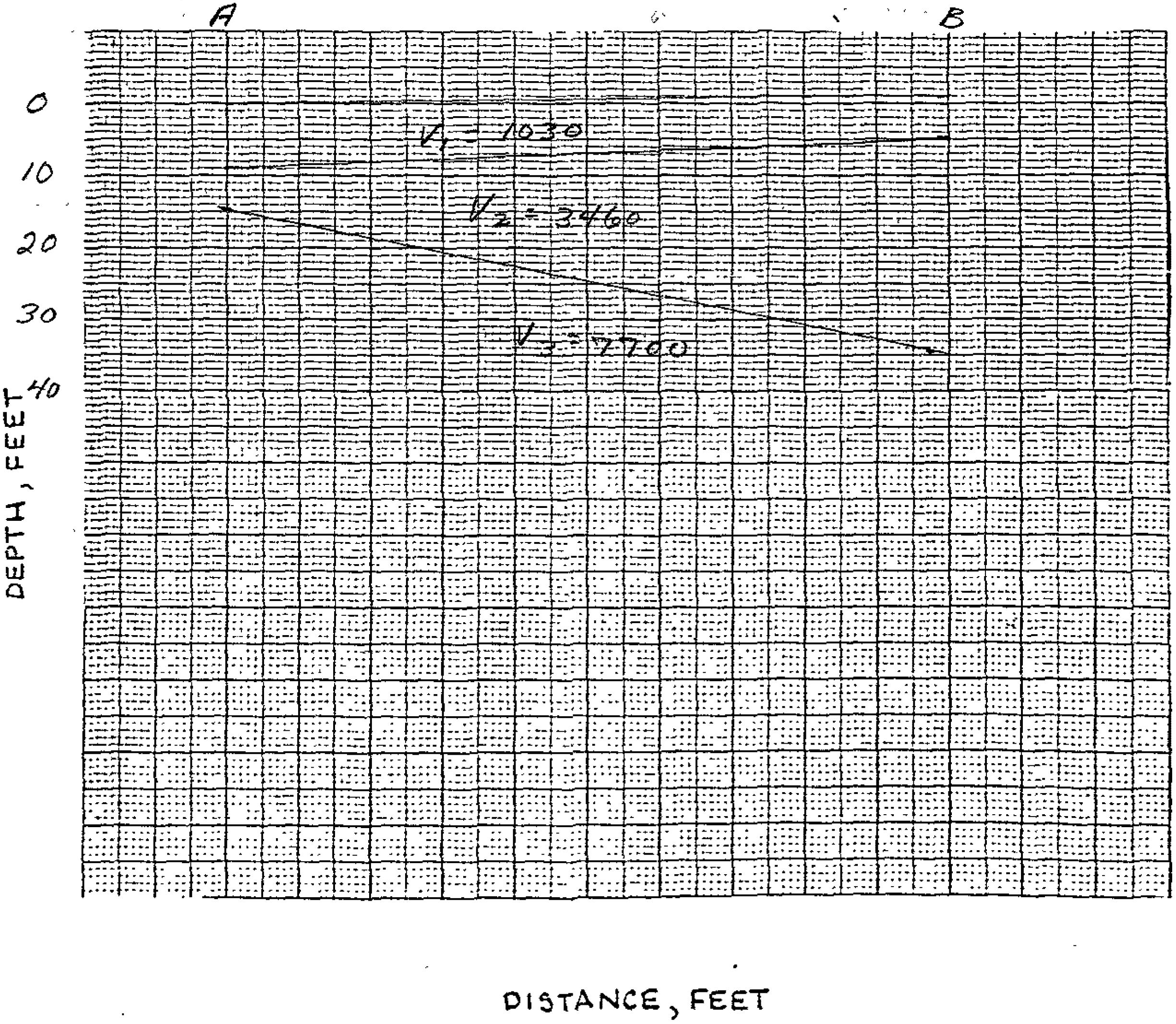
ANDERSON DAM
SPILLWAY ENLARGEMENT

SEISMIC REFRACTION
DATA SUMMARY SHEET

PROJECT NO.	DATE	SHEET NO.
SCU-124A		1 OF 1

LOCATION SEE FIGURE III-2
LINE NO. SL-4
LINE BEARING (A TO B) N 60° E
PERFORMED BY ES
LINE LENGTH 100'
DATE 7/7/83

V_1 1030
W_2 . . . . 2.41
V_2 3460
HA_1 . . . . 9.0
HB_1 . . . . 5.9
W_3 . . . . -14.27
V_3 7700
HA_2 . . . . 5.7
HB_2 . . . . 29.3



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ANDERSON DAM
SPILLWAY ENLARGEMENT

SEISMIC REFRACTION
DATA SUMMARY SHEET

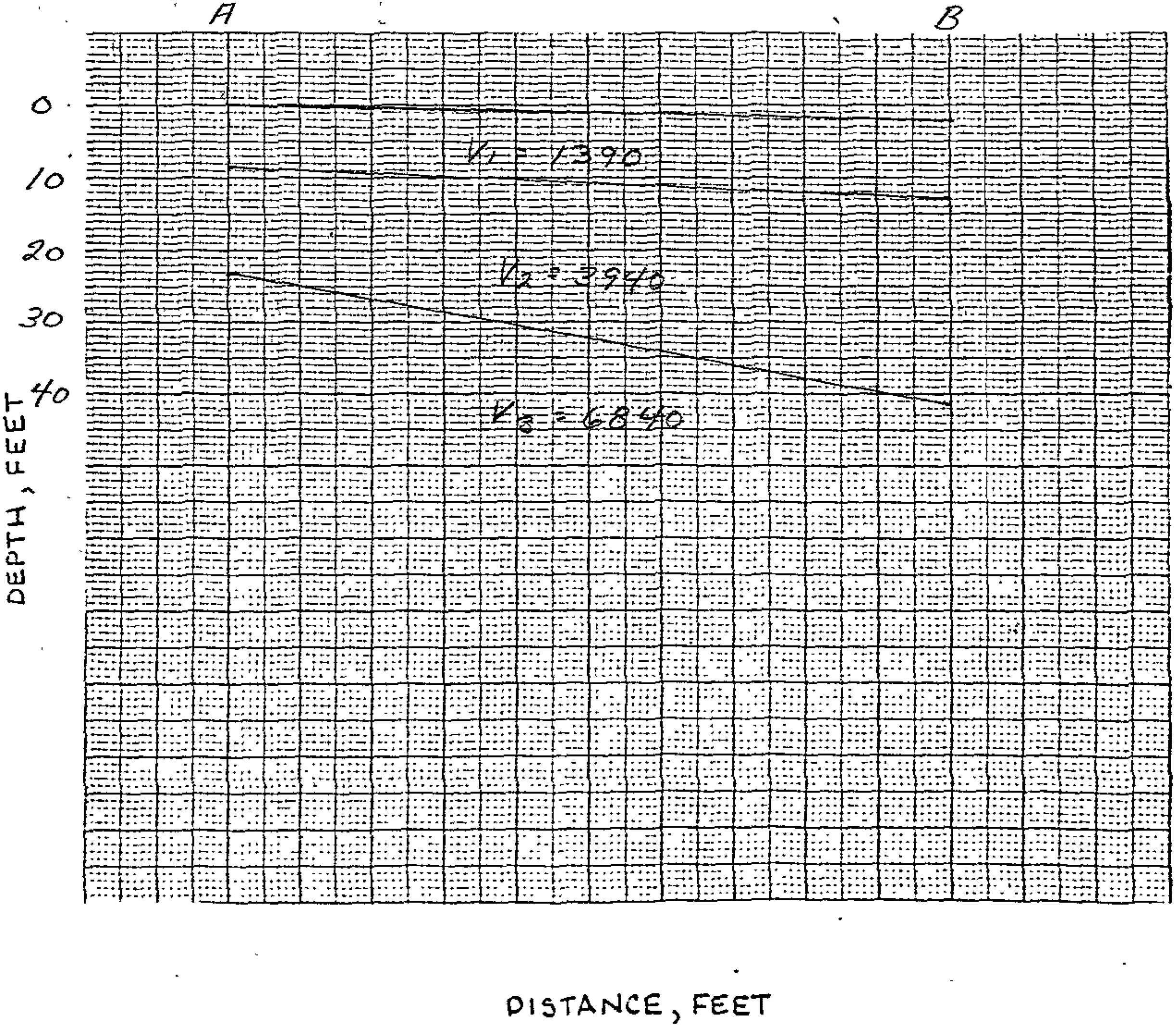
PROJECT NO.	DATE	SHEET NO.
SCV-124 A		1 OF 1

LOCATION *SEE FIGURE III-2* LINE NO. *SL-5*

LINE BEARING (A TO B) *S 52° W* PERFORMED BY *ES*

LINE LENGTH *100'* DATE *7/7/83*

V_1	1390
W_2	− 0.98
V_2	3940
HA_1	8.5
HB_1	11.4
W_3	− 6.09
V_3	6840
HA_2	14.7
HB_2	22.8



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ANDERSON DAM
SPILLWAY ENLARGEMENT

SEISMIC REFRACTION
DATA SUMMARY SHEET

PROJECT NO.	DATE	SHEET NO.
SCV-124A		1 OF 1

LOCATION SEE FIGURE III-2

LINE NO. SL-6

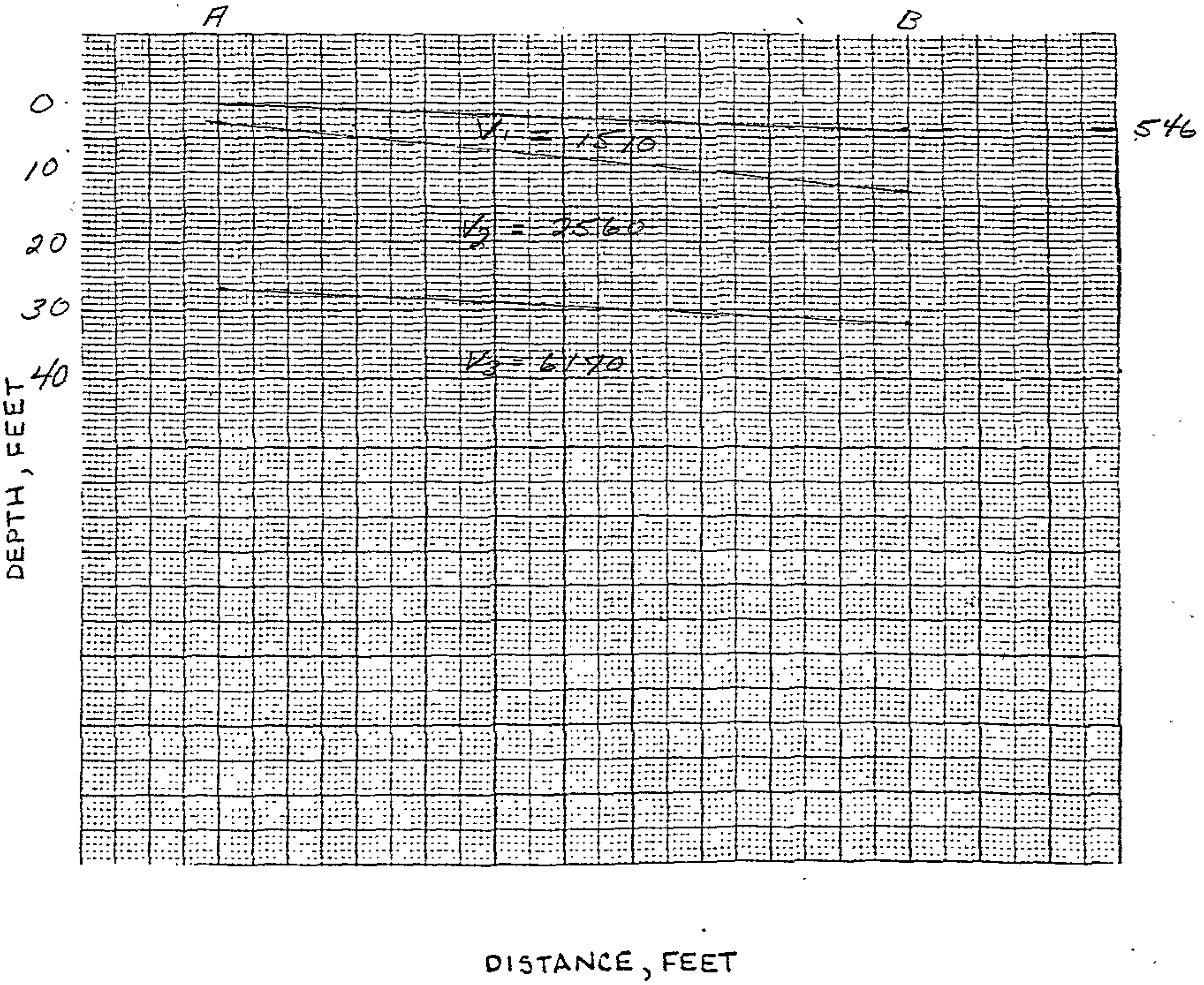
LINE BEARING (A TO B) S 81° W

PERFORMED BY ES

LINE LENGTH 100'

DATE 7/8/83

V_1	1510
W_2	-5.8
V_2	2560
HA_1	2.5
HB_1	8.5
W_3	-1.5
V_3	6170
HA_2	23.7
HB_2	18.9



Wahler Associates	ANDERSON DAM SPILLWAY ENLARGEMENT	SEISMIC REFRACTION DATA SUMMARY SHEET	
PALO ALTO • NEWPORT BEACH • DENVER	PROJECT NO. SCV-124A	DATE	SHEET NO. 1 OF 1

LOCATION SEE FIGURE III-2

LINE NO. SL-7

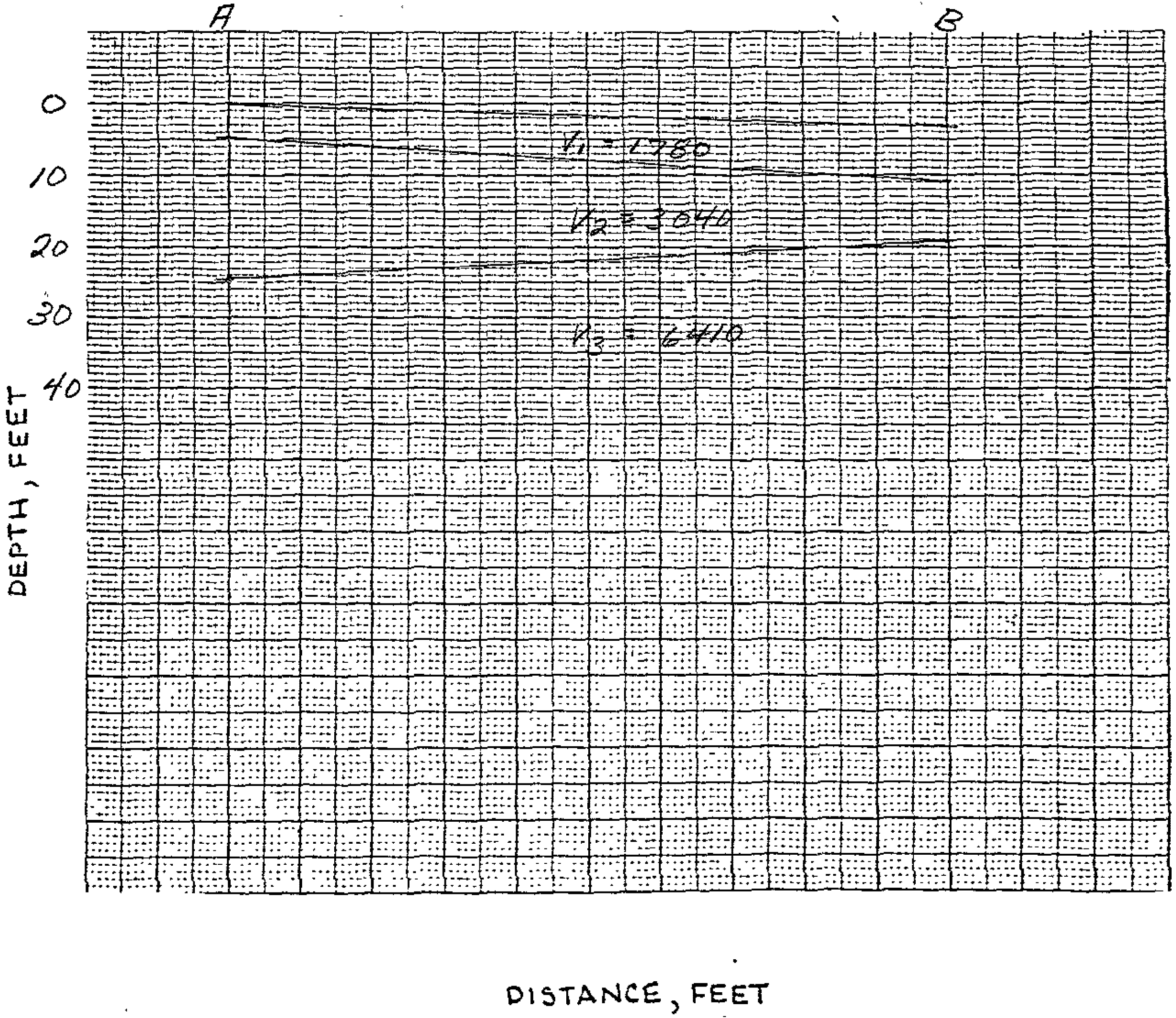
LINE BEARING (A TO B) S 80° W

PERFORMED BY ES

LINE LENGTH 100'

DATE 7/8/83

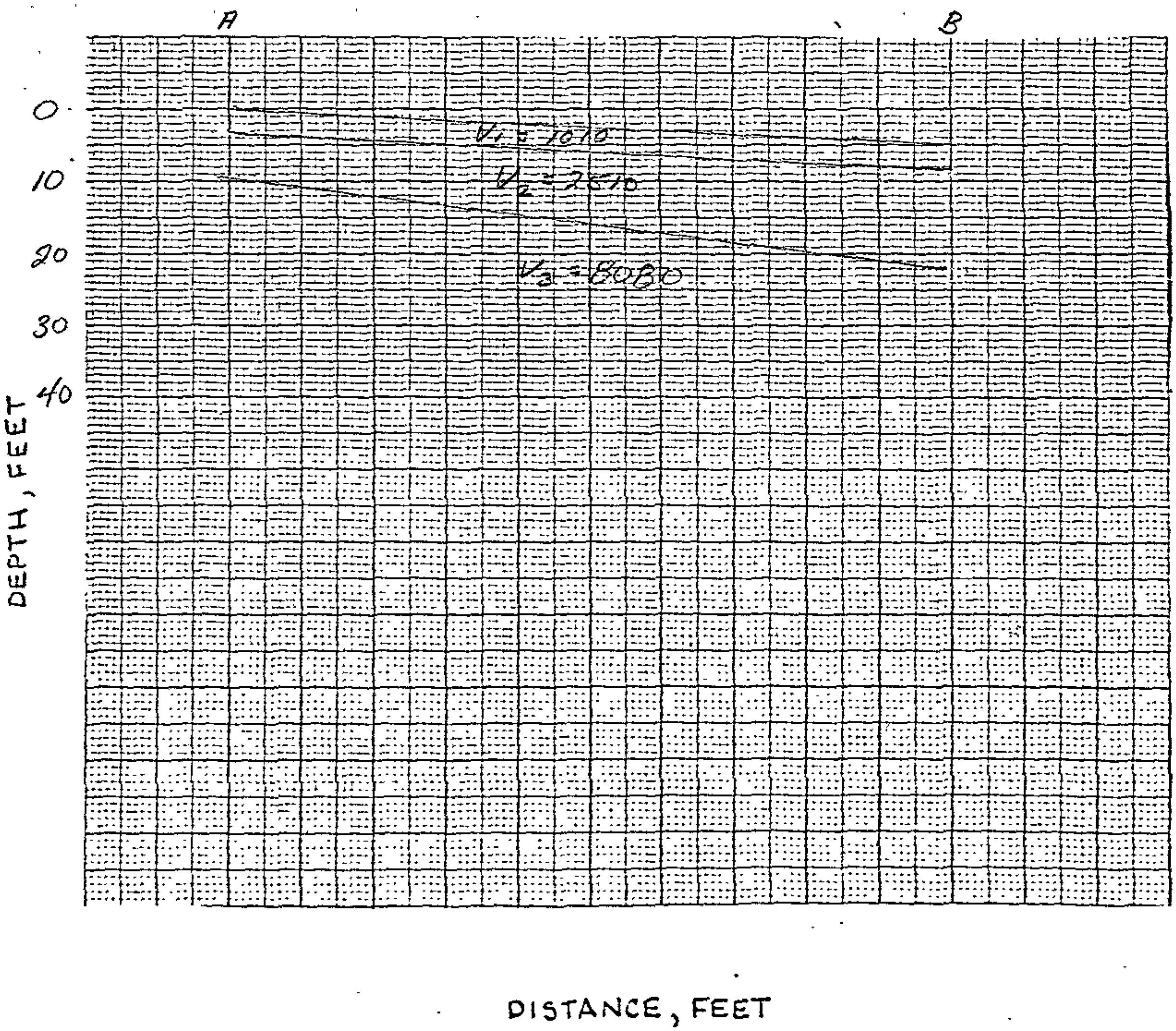
V_1	1780
W_2	-0.5
V_2	3040
HA_1	4.8
HB_1	7.2
W_3	4.1
V_3	6410
HA_2	19.2
HB_2	7.6



Wahler Associates	ANDERSON DAM SPILLWAY ENLARGEMENT	SEISMIC REFRACTION DATA SUMMARY SHEET	
PALO ALTO • NEWPORT BEACH • DENVER	PROJECT NO.	DATE	SHEET NO.
	SCV-124 A		1 OF 1

LOCATION SEE FIGURE III-2
LINE NO. SL-8
LINE BEARING (A TO B) N85°W
PERFORMED BY ES
LINE LENGTH 100'
DATE 7/8/83

V_1	1010
W_2	1.7
V_2	2510
HA_1	3.0
HB_1	3.3
W_3	-7.8
V_3	8080
HA_2	6.1
HB_2	13.2



Wahler Associates PALO ALTO • NEWPORT BEACH • DENVER	ANDERSON DAM SPILLWAY ENLARGEMENT	SEISMIC REFRACTION DATA SUMMARY SHEET	
PROJECT NO.	DATE	SHEET NO.	
SCV-124A		1 OF 1	

LOCATION SEE FIGURE III-2

LINE NO. SL-9

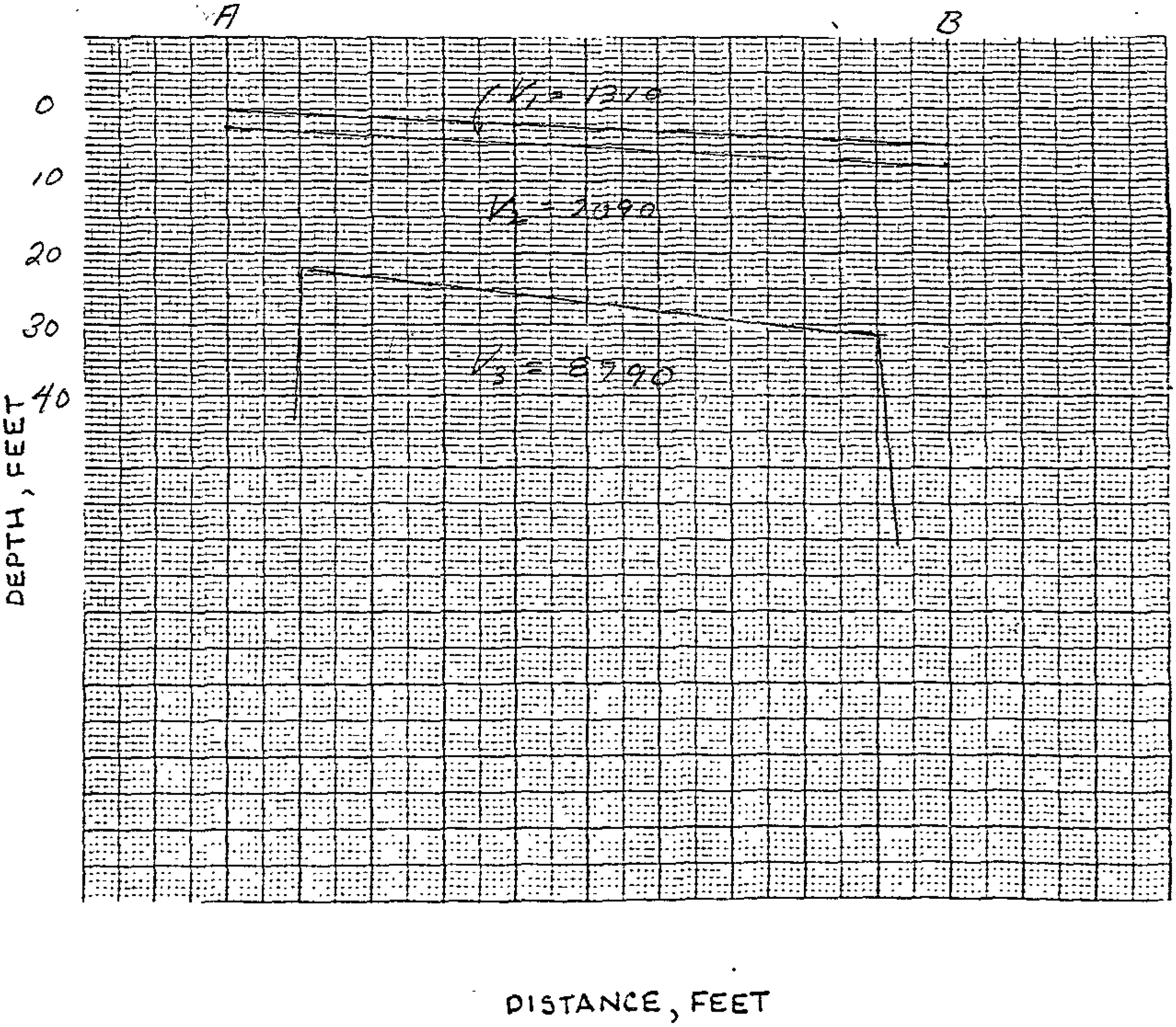
LINE BEARING (A TO B) S55°W

PERFORMED BY ES

LINE LENGTH 100'

DATE 7/8/83

V_1	1310
W_2	6.2
V_2	2090
HA_1	2.3
HB_1	2.1
W_3	-11.5
V_3	8790
HA_2	18.2
HB_2	26.5



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SPILLWAY ENLARGEMENT

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SEISMIC REFRACTION
DATA SUMMARY SHEET

PROJECT NO.	DATE	SHEET NO.
SCV-124A		1 OF 1

LOCATION SEE FIGURE III-2

LINE NO. SL-10

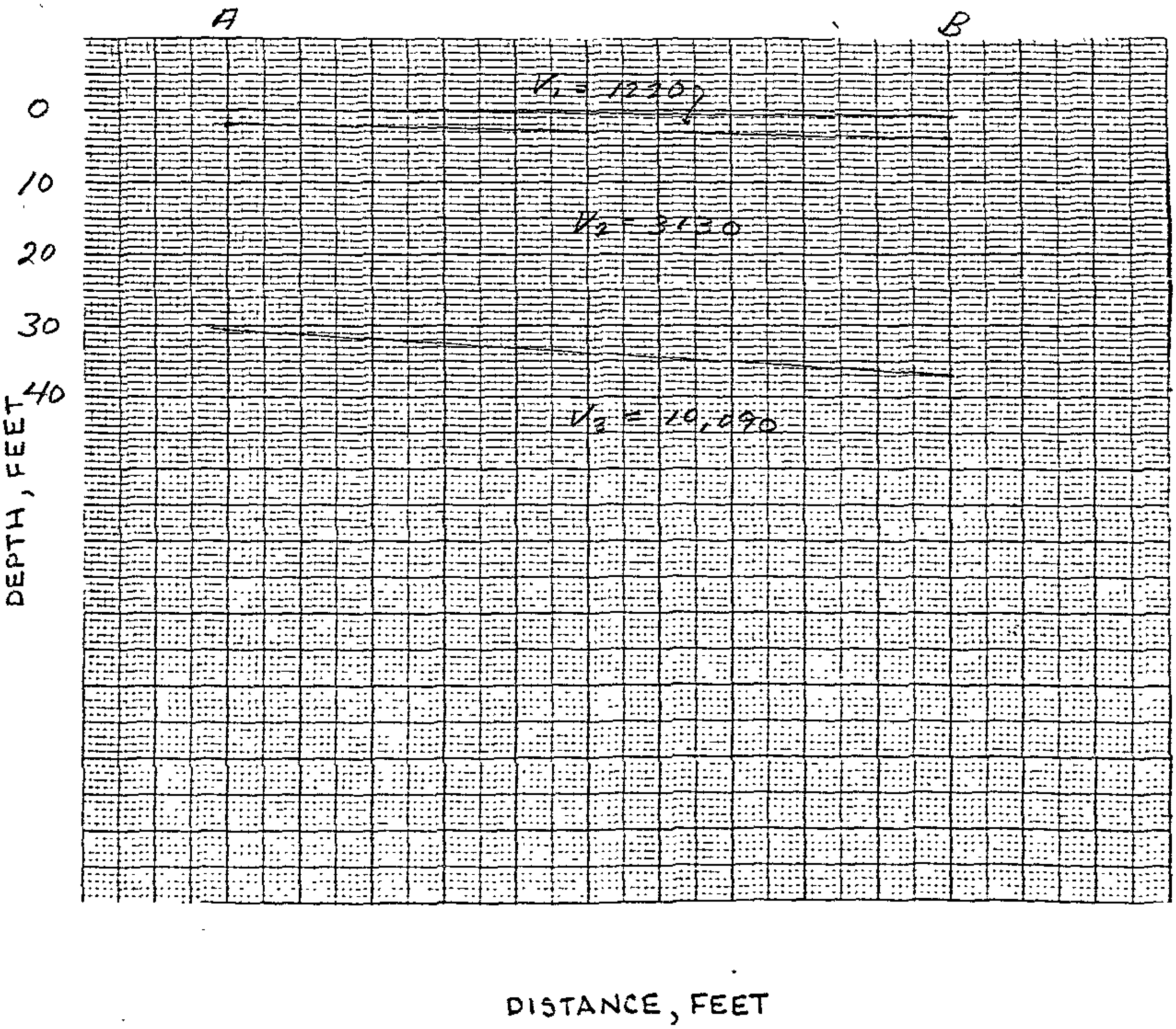
LINE BEARING (A TO B) N 72°E

PERFORMED BY ES

LINE LENGTH 100'

DATE 7/8/83

V_1	1220
W_2	8.9
V_2	3130
HA_1	1.8
HB_1	2.7
W_3	-15.9
V_3	10,090
HA_2	28.5
HB_2	32.4



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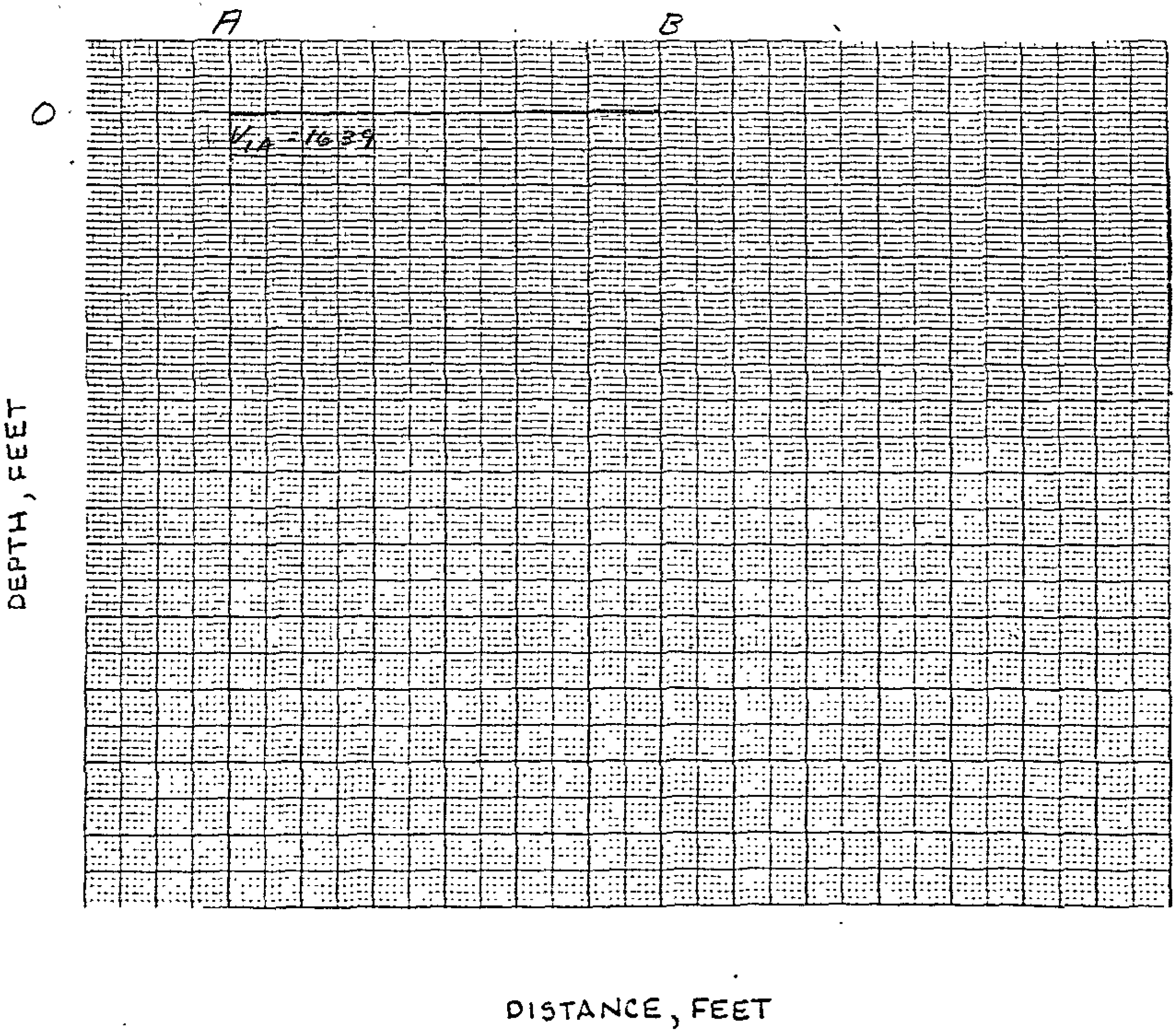
PROJECT NO.	DATE	SHEET NO.	
SCV-124 A		1 OF 1	

LOCATION *SEE FIGURE III-1* LINE NO. *SL-11*

LINE BEARING (A TO B) *N15°E* PERFORMED BY *ASB*

LINE LENGTH *60'* DATE

V_1	1610
W_2	15.5
V_2	1970
HA_1	6.8
HB_1	0
W_3	60
V_3	
HA_2	
HB_2	



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ANDERSON DAM
SPILLWAY ENLARGEMENT

SEISMIC REFRACTION
DATA SUMMARY SHEET

PROJECT NO.	DATE	SHEET NO.
SCV-124 A		*1* OF *1*

POC NOV 80

EXPLORATION TRENCH LOGS

6/83

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ANDERSON DAM
SPILLWAY ENLARGEMENT

PROJECT NO. SCV-124 A

DATE

FIGURE NO.

GRAPHIC TRENCH LOG

TRENCH NO. T-1
SHEET 1 OF 2

LOCATION: See Figure III-1
NOTES:

UNITS			STRUCTURE			
DEPTH	NO.	DESCRIPTION	NO.	STRIKE	DIP	TYPE
	①	serpentine: gray and yellow; crushed; soil-like w/some gravel-cobble size pieces of hard serp; moist.	1	N50°E	20° SE	Shear
	②	colluvium: dark brown; clayey sand and clayey gravel w/cobbles; angular to rounded; some organics	2	N35°E	55° SE	Joint

STATION →

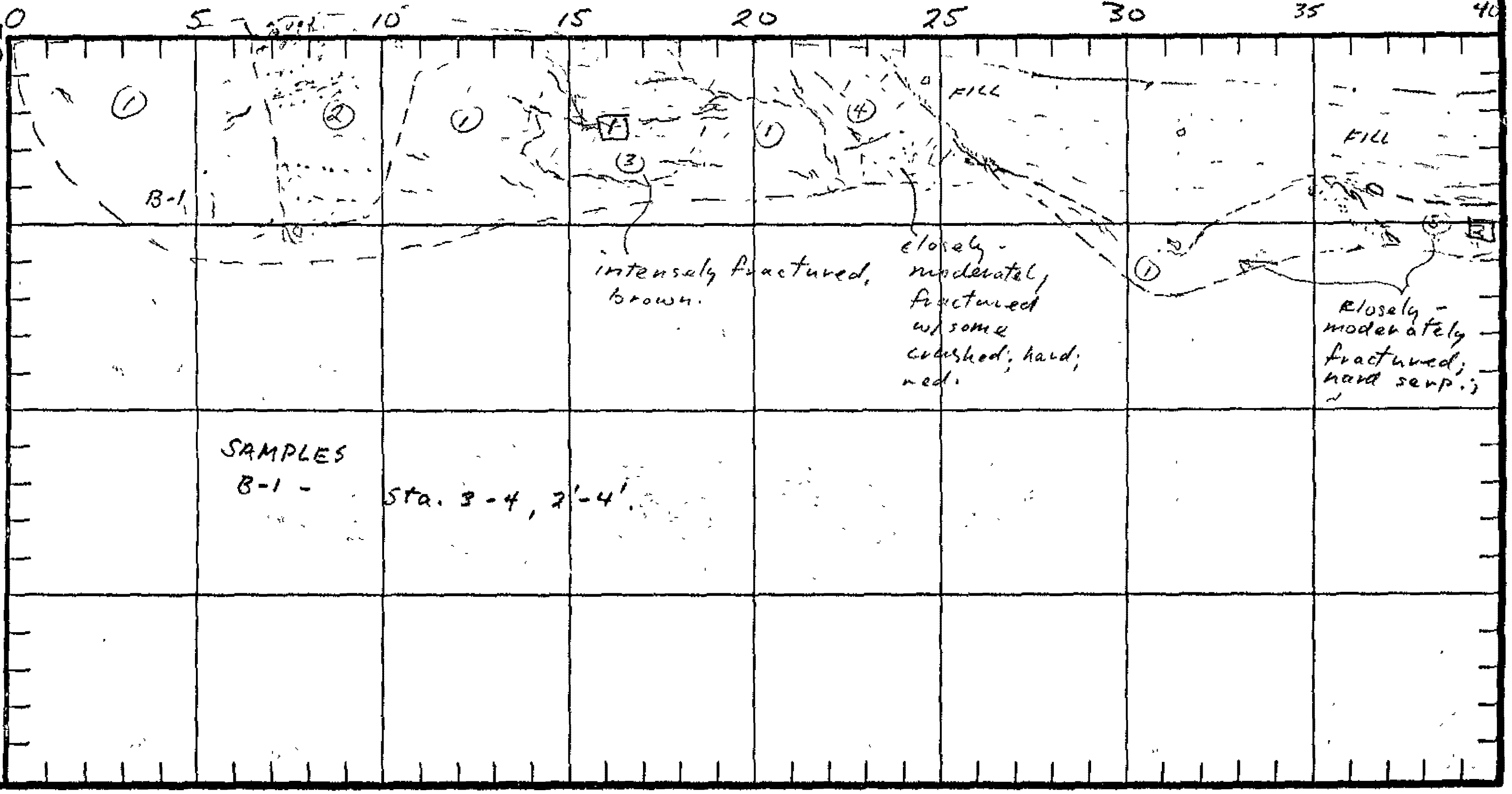
DEPTH (EL.)

6/20/83
DATE

ES
LOGGED BY

SCALE, FT.
0 5

N30°E
BEARING →



0
5
10
15
20
25
30
35
40
5
10
①
②
①
1
③
①
④
FILL
FILL
B-1
①
⑤
2
intensely fractured, brown.
closely-moderatel, fractured w/some crushed; hard; red.
closely-moderately fractured; hard serp.;

SAMPLES
B-1 - Sta. 3-4, 2'-4'.

8/83

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TRENCH NO. T-1

SHEET 2 OF 2

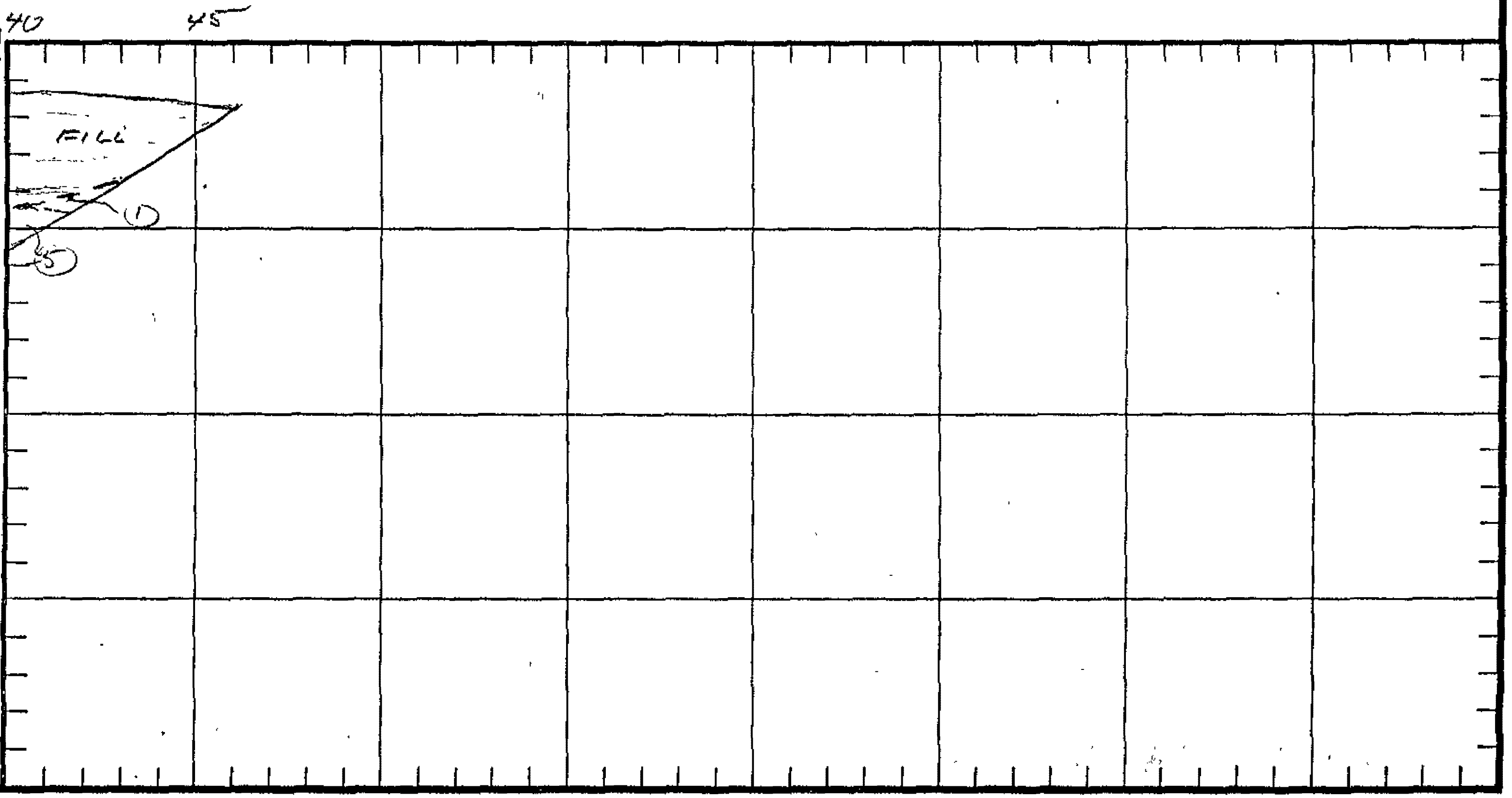
LOCATION:

NOTES:

UNITS			STRUCTURE			
DEPTH	NO.	DESCRIPTION	NO.	STRIKE	DIP	TYPE
THIS LOG INDICATES CONDITIONS IN THIS TEST PIT OR TRENCH ONLY ON THE DATE INDICATED AND MAY NOT REPRESENT CONDITIONS AT OTHER LOCATIONS AND ON OTHER DATES. ANY WATER LEVELS SHOWN ARE SUBJECT TO VARIATION. STRATIFICATION LINES OR DEPTH INTERVALS REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN MATERIAL TYPES AND THE TRANSITIONS MAY BE GRADUAL. SOIL CLASSIFICATIONS SHOWN ON LOG ARE FIELD CLASSIFICATIONS BASED ON THE UNIFIED SOILS CLASSIFICATION SYSTEM.						

STATION →

DEPTH (EL.)



DATE

LOGGED BY

SCALE, FT.

BEARING →

PROJECT NO.

DATE

FIGURE NO.

GRAPHIC TRENCH LOG

8/83

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PALO ALTO ● NEWPORT BEACH ● DENVER

ANDERSON DAM
SPILLWAY ENLARGEMENT

PROJECT NO. SCV-124A

DATE

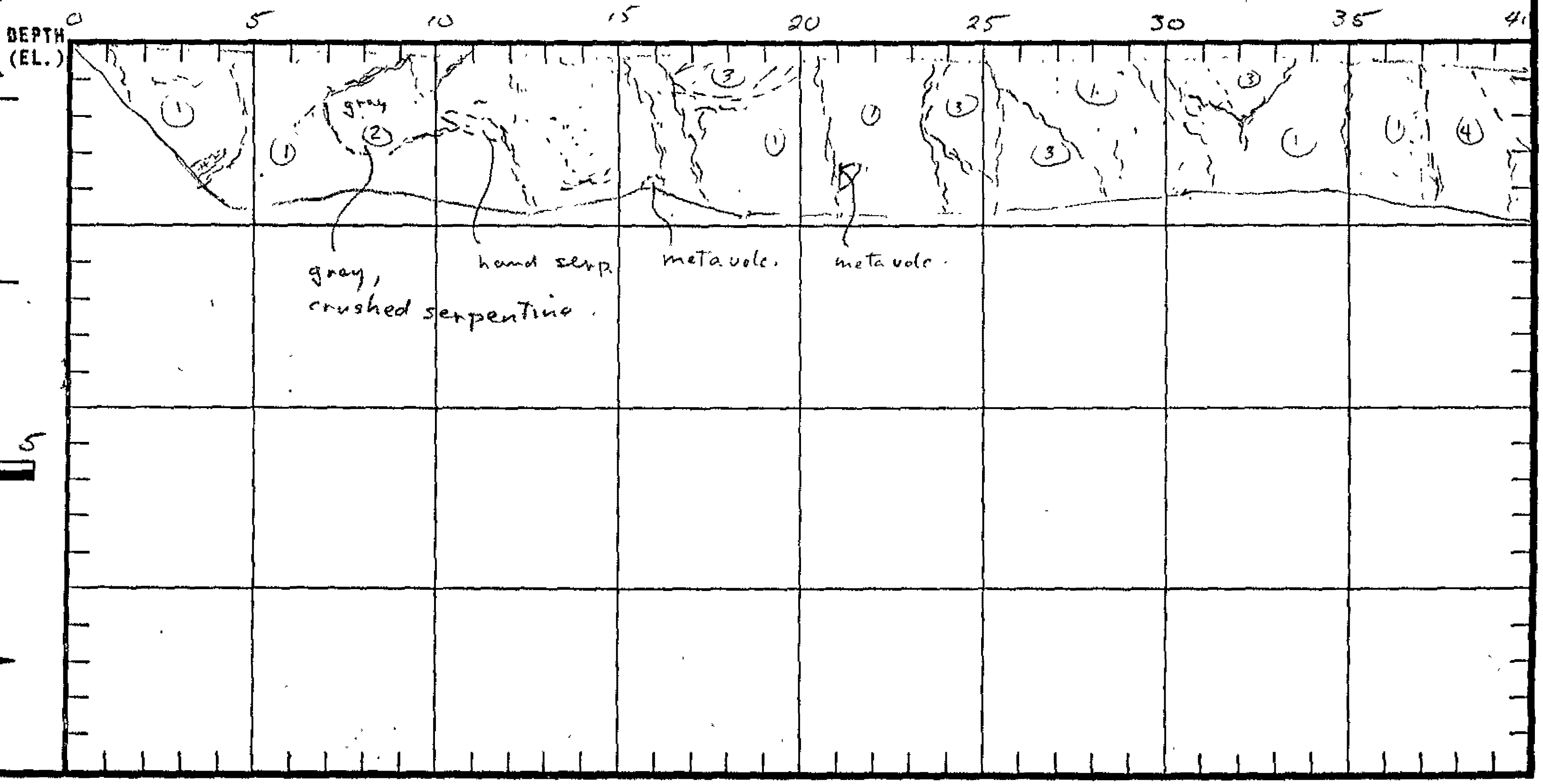
FIGURE NO.

GRAPHIC TRENCH LOG

TRENCH NO. T-2
SHEET 1 OF 2
LOCATION: See Figure III-1
NOTES:

UNITS			STRUCTURE			
DEPTH	NO.	DESCRIPTION	NO.	STRIKE	DIP	TYPE
	(1)	Crushed zone; yellow, crushed, oxidized appearance, soil-like; contains fragments of aphanitic rock, possibly metavolcanic.				
	②	serpentine; crushed, light grey, soil like.				
	③	metavolcanic: light brown - brown; aphanitic; hard; closely fractured; weak - moderately strong.				
	④	Crushed zone; dark gray, crushed; soil-like; contains fragments of hard aphanitic rock.				

STATION →



6/20/83
DATE

ES
LOGGED BY

0 5
SCALE, FT.

N 37°E
BEARING →

6/83

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TRENCH NO. T-2

SHEET 2 OF 2

LOCATION:

NOTES:

UNITS			STRUCTURE			
DEPTH	NO.	DESCRIPTION	NO.	STRIKE	DIP	TYPE

THIS LOG INDICATES CONDITIONS IN THIS TEST PIT OR TRENCH ONLY ON THE DATE INDICATED AND MAY NOT REPRESENT CONDITIONS AT OTHER LOCATIONS AND ON OTHER DATES. ANY WATER LEVELS SHOWN ARE SUBJECT TO VARIATION.

STRATIFICATION LINES OR DEPTH INTERVALS REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN MATERIAL TYPES AND THE TRANSITIONS MAY BE GRADUAL.

SOIL CLASSIFICATIONS SHOWN ON LOG ARE FIELD CLASSIFICATIONS BASED ON THE UNIFIED SOILS CLASSIFICATION SYSTEM.

STATION →

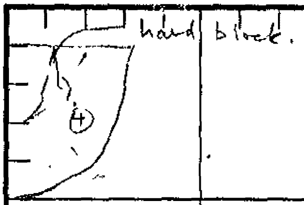
DEPTH (EL.)

DATE

LOGGED BY

SCALE, FT.

BEARING →



PROJECT NO.

DATE

FIGURE NO.

GRAPHIC TRENCH LOG

8/83

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ANDERSON DAM SPILLWAY ENLARGEMENT

PROJECT NO. SCV-124A
DATE
FIGURE NO.

GRAPHIC TRENCH LOG

TRENCH NO. T-3
SHEET 1 OF 2
LOCATION: See Figure III-1
NOTES: Trench bearing changes @ station 40.

UNITS			STRUCTURE			
DEPTH	NO.	DESCRIPTION	NO.	STRIKE	DIP	TYPE
	(1)	serpentine: gray-dark gray; sheared, intensely fractured to crushed; slickensided, appears rock-like but is friable, weak, soapy feel, moist.	1	N42°W	~90°	slickenside contact.
	(2)	serpentine: light green-gray, some rust; crushed, appears to have rock structure but is soil-like friable, moist; slickensided	2	N55°W	75°SW	fault gouge.
	(3)	serpentine: dark grey, crushed, soil-like, moist.				

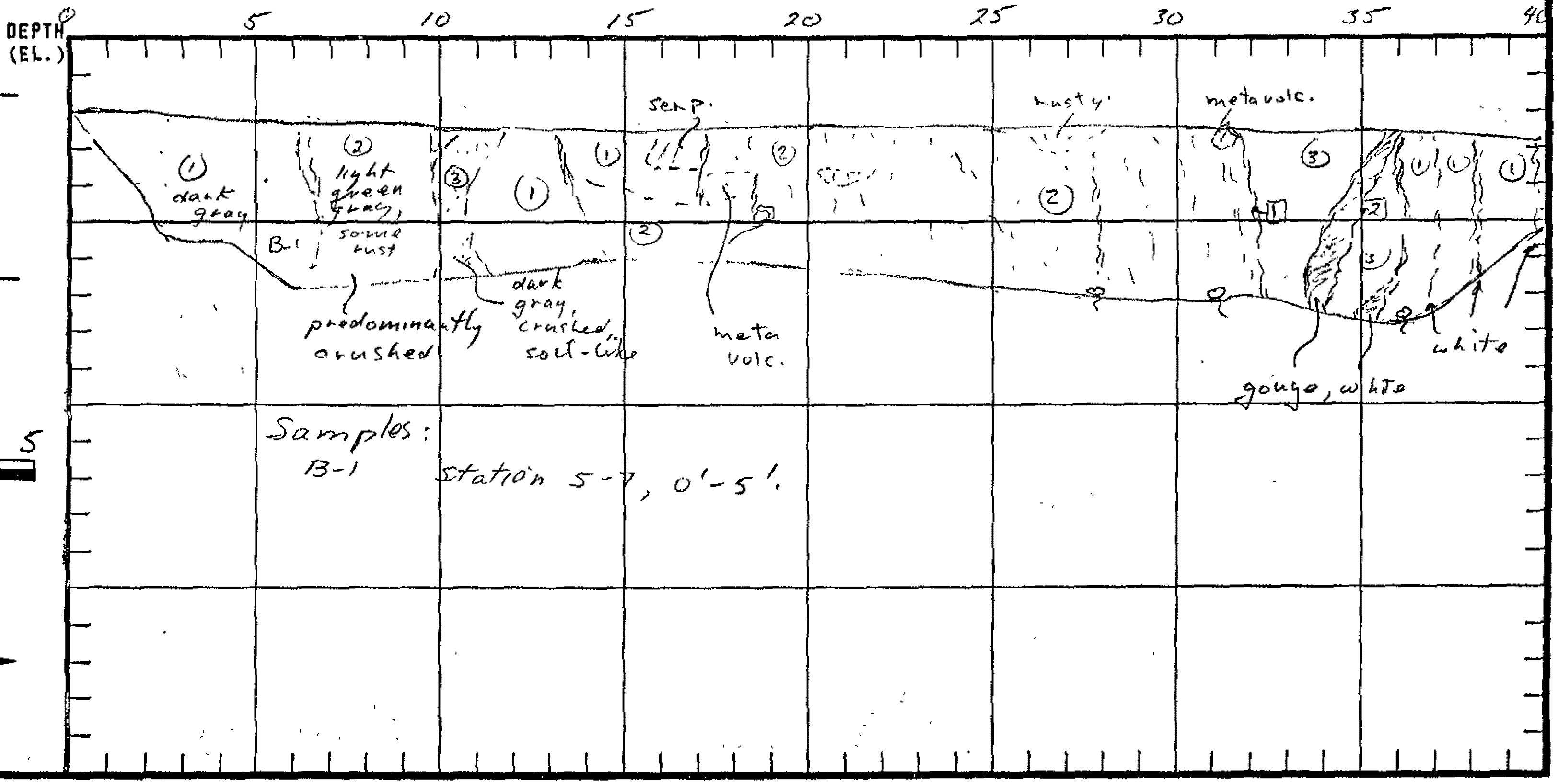
STATION →

DATE 6/20/83

LOGGED BY ES

SCALE, FT. 0 5

BEARING N 37°E



Samples:
B-1 station 5-7, 0'-5'.

8/83

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GRAPHIC TRENCH LOG

PROJECT NO.

DATE

FIGURE NO.

TRENCH NO. T-3

SHEET 2 OF 2

LOCATION:

NOTES:

THIS LOG INDICATES CONDITIONS IN THIS TEST PIT OR TRENCH ONLY ON THE DATE INDICATED AND MAY NOT REPRESENT CONDITIONS AT OTHER LOCATIONS AND ON OTHER DATES. ANY WATER LEVELS SHOWN ARE SUBJECT TO VARIATION.

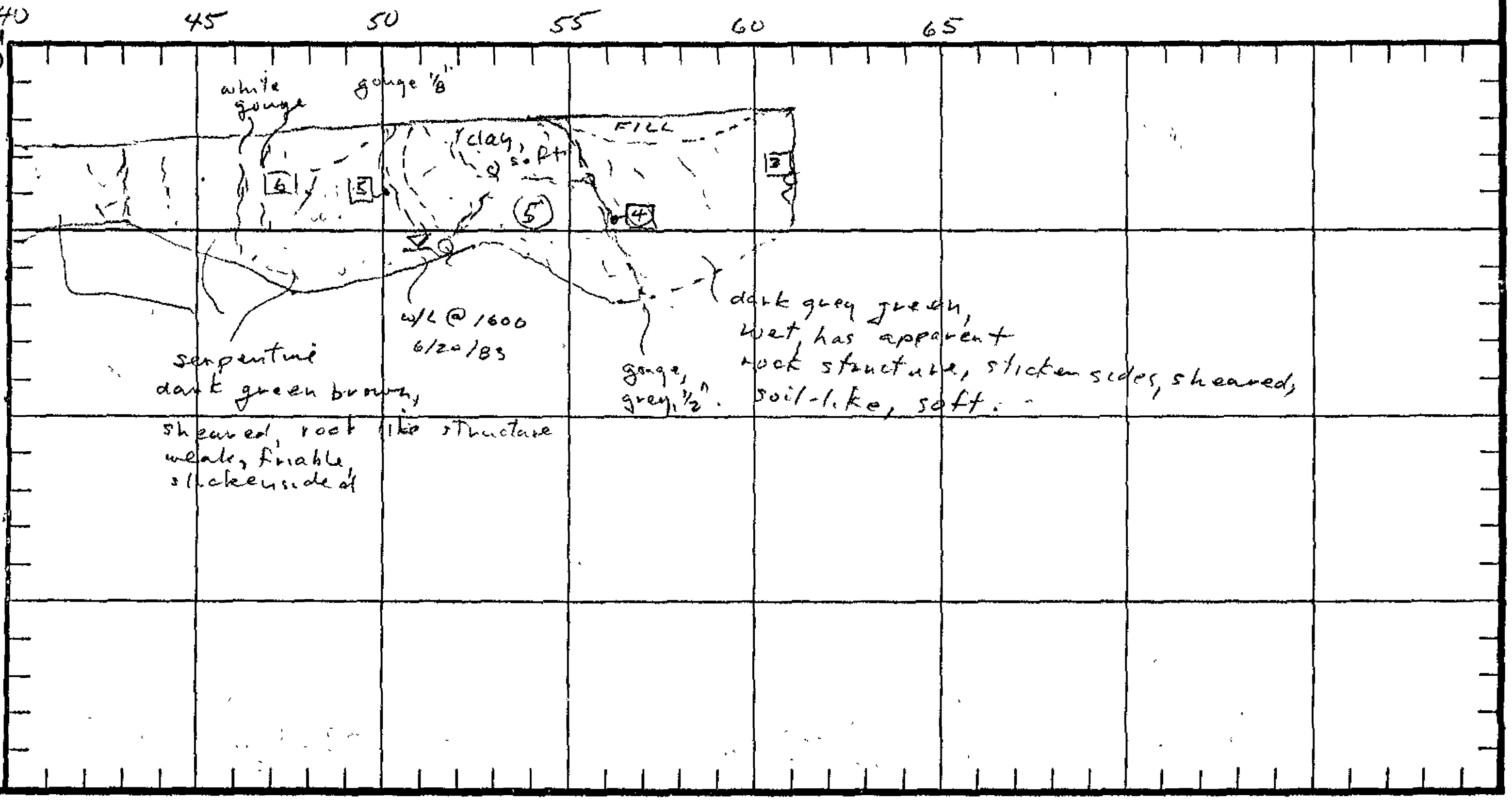
STRATIFICATION LINES OR DEPTH INTERVALS REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN MATERIAL TYPES AND THE TRANSITIONS MAY BE GRADUAL.

SOIL CLASSIFICATIONS SHOWN ON LOG ARE FIELD CLASSIFICATIONS BASED ON THE UNIFIED SOILS CLASSIFICATION SYSTEM.

UNITS			STRUCTURE			
DEPTH	NO.	DESCRIPTION	NO.	STRIKE	DIP	TYPE
	(5)	Altered zone(?). med. grey; altered to clay, appears to show relic rock texture; sheared; aphanitic, possibly altered metavolcanic.	3	N64°E	90°	slickenside fracture.
			4	N60°W	~90	Gouge
			5	N70°W	~80° NE	gouge
			6	N48E	73° SE	slickenside fracture

STATION →

DEPTH (EL.)


40
45
50
55
60
65
white gouge
gouge 1/8"
clay, soft
FILL
6
5
3
(5)
4
w/L @ 1600 6/20/83
serpentine dark green brown, sheared, rock like structure weak, friable, slickensided
gouge, grey, 1/2".
dark grey green, wet, has apparent rock structure, slickensides, sheared, soil-like, soft.

6/20/83
DATE

ES
LOGGED BY

0 5
SCALE, FT.

N 44°E
BEARING →

8/83

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ANDERSON DAM SPILLWAY ENLARGEMENT

PROJECT NO. SCV-124 A

DATE

FIGURE NO.

GRAPHIC TRENCH LOG

TRENCH NO. T-4

SHEET 1 OF 1

LOCATION: See Figure III-1

NOTES:

DEPTH	UNITS NO.	UNITS DESCRIPTION	STRUCTURE NO.	STRIKE	DIP	TYPE
	①	serpentine: hard, cobble-boulder size nodules w/ crushed, friable, soil-like materials; slickensided dark, light.	[1]	N70°W	~90°	contact slickensided.
	②	Serpentine: sheared; has rock-like structure appearance, but is soil-like, friable	[2]	N68°W	~90°	slickensided fracture

THIS LOG INDICATES CONDITIONS IN THIS TEST PIT OR TRENCH ONLY ON THE DATE INDICATED AND MAY NOT REPRESENT CONDITIONS AT OTHER LOCATIONS AND ON OTHER DATES. ANY WATER LEVELS SHOWN ARE SUBJECT TO VARIATION.

STRATIFICATION LINES OR DEPTH INTERVALS REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN MATERIAL TYPES AND THE TRANSITIONS MAY BE GRADUAL.

SOIL CLASSIFICATIONS SHOWN ON LOG ARE FIELD CLASSIFICATIONS BASED ON THE UNIFIED SOILS CLASSIFICATION SYSTEM.

STATION →

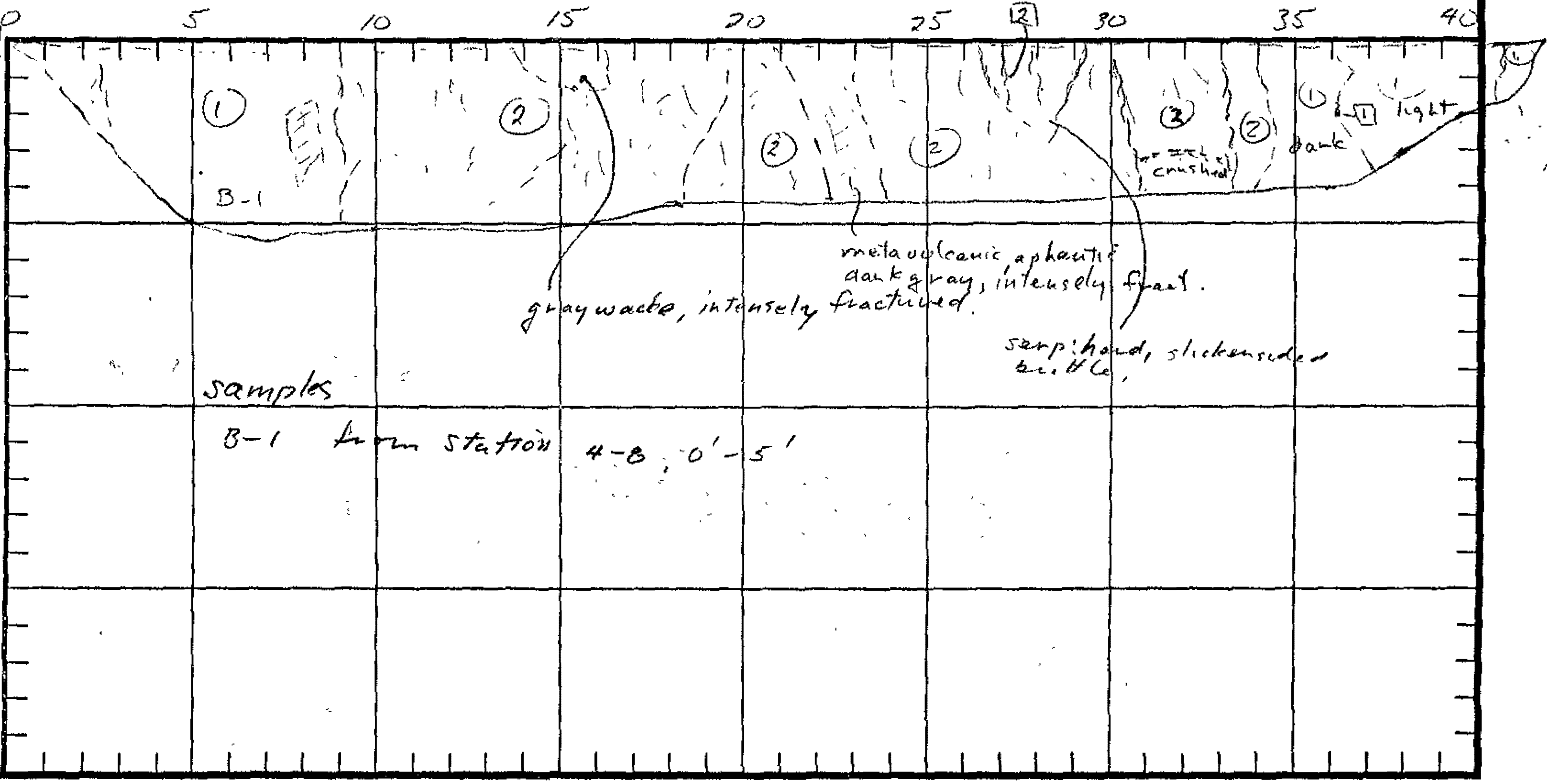
DEPTH (EL.)

6/20/83
DATE

EG
LOGGED BY

0 5
SCALE, FT.

N 30° E
BEARING →


0
5
10
15
20
25
[2]
30
35
40
①
②
②
②
③
②
①
[1]
light
dark
crushed
B-1
graywacke, intensely fractured.
metavolcanic aphanitic dark gray, intensely fract.
serp: hard, slickensided brittle,

samples

B-1 from station 4-8, 0'-5'

6/83

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PALO ALTO ● NEWPORT BEACH ● DENVER

ANDERSON DAM
SPILLWAY EXCAVATION

GRAPHIC TRENCH LOG

PROJECT NO. SCV-124 A

DATE

FIGURE NO.

TRENCH NO. T-5

SHEET 1 OF 2

LOCATION: See Figure III-1

NOTES: Trench required dewatering; used sumps on SE side.

UNITS			STRUCTURE			
DEPTH	NO.	DESCRIPTION	NO.	STRIKE	DIP	TYPE
	①	serpontine. dark grey w/ green, hard, gravel to cobble size pieces w/ crushed, friable to weak ground mass; appears rock-like.	1	N85°E	90°	slickenside contact.
	②	serpentine; gray w/green; crushed, sheared; intimately slickensided; appears rock-like, but is soil like	2	N55°W	29°	fault contact
			3	N70°E	90°	joint.

STATION →

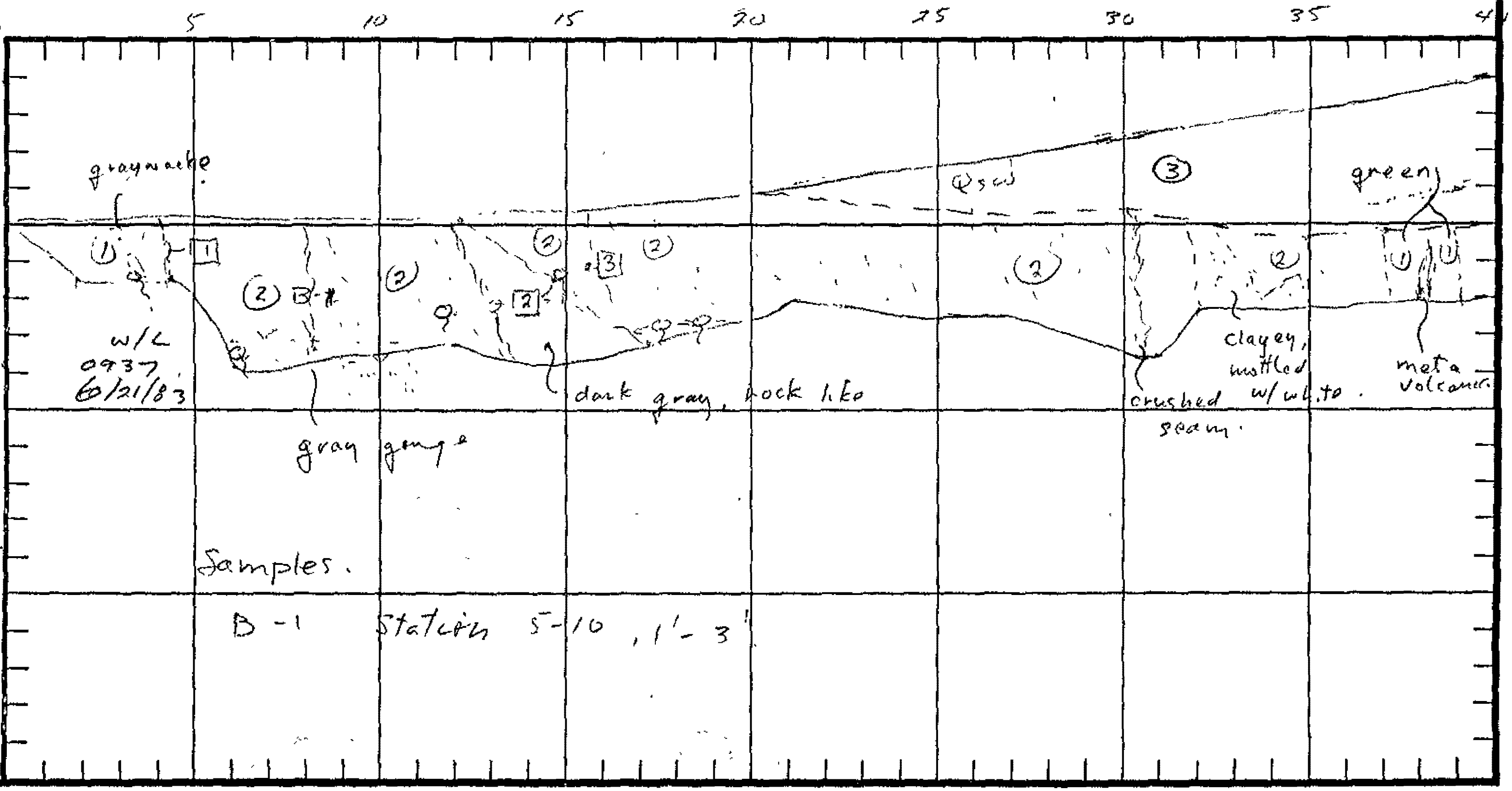
DEPTH (EL.)

6/21/83
DATE

ES
LOGGED BY

0 5
SCALE, FT.

N28°E
BEARING



Samples.

B-1 Station 5-10, 1'-3'

8/83

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PALO ALTO ● NEWPORT BEACH ● DENVER

TRENCH NO. T-5
SHEET 2 OF 2
LOCATION:
NOTES:

UNITS			STRUCTURE			
DEPTH	NO.	DESCRIPTION	NO.	STRIKE	DIP	TYPE
	③	Slope wash; brown, clayey sand, moist, slight - moderate plasticity.	4	N70°W	72° SW	Fault

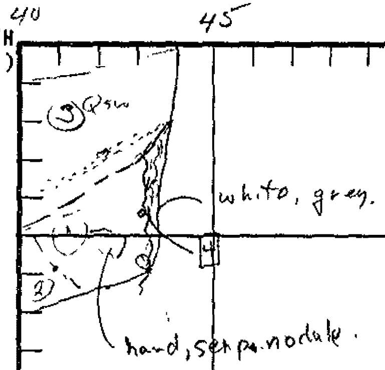
THIS LOG INDICATES CONDITIONS IN THIS TEST PIT OR TRENCH ONLY ON THE DATE INDICATED AND MAY NOT REPRESENT CONDITIONS AT OTHER LOCATIONS AND ON OTHER DATES. ANY WATER LEVELS SHOWN ARE SUBJECT TO VARIATION.

STRATIFICATION LINES OR DEPTH INTERVALS REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN MATERIAL TYPES AND THE TRANSITIONS MAY BE GRADUAL.

SOIL CLASSIFICATIONS SHOWN ON LOG ARE FIELD CLASSIFICATIONS BASED ON THE UNIFIED SOILS CLASSIFICATION SYSTEM.

STATION →

DEPTH (EL.)



DATE

LOGGED BY

SCALE, FT.

BEARING →

PROJECT NO.

DATE

FIGURE NO.

GRAPHIC TRENCH LOG

8/83

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PALO ALTO ● NEWPORT BEACH ● DENVER

ANDERSON DAM
SPILLWAY EXCAVATION

GRAPHIC TRENCH LOG

PROJECT NO. SCV-124 A

DATE

FIGURE NO.

TRENCH NO. T-6

SHEET 1 OF 1

LOCATION: See Figure III-1,

NOTES:

UNITS			STRUCTURE			
DEPTH	NO.	DESCRIPTION	NO.	STRIKE	DIP	TYPE
	(1)	FILL: Gravelly clayey sand, brown, moist, contains various but minor amount of debris (wire, wood).				
	(2)	metavolcanic(?); yellow brown; crushed, altered, soil-like, but w/ gravel size pieces of metavolcanic rock.				

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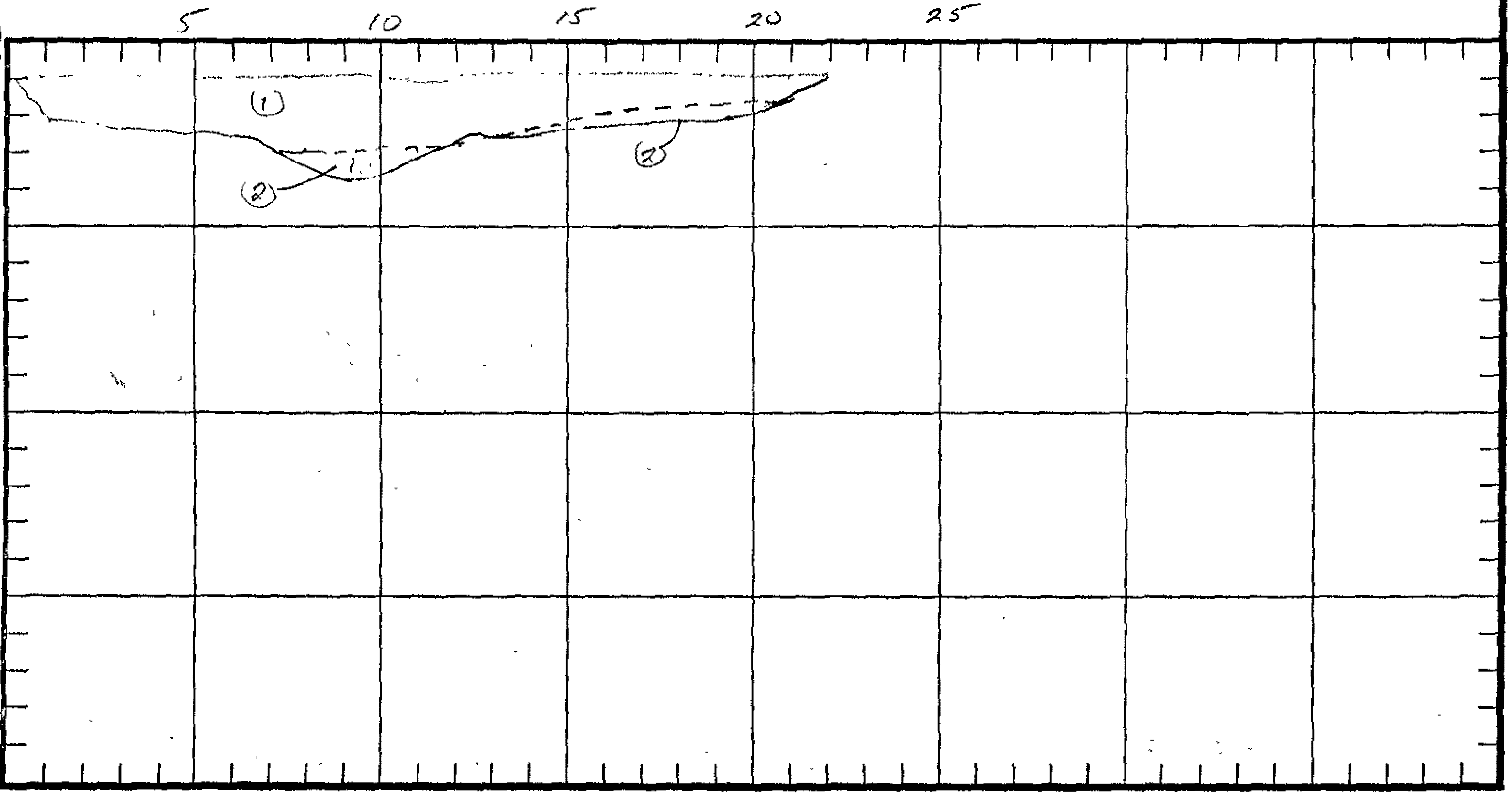
SOIL CLASSIFICATIONS SHOWN ON LOG ARE FIELD CLASSIFICATIONS BASED ON THE UNIFIED SOILS CLASSIFICATION SYSTEM.

STATION →

DEPTH (EL.)



DATE: 6/21

LOGGED BY: E.B.

SCALE, FT. 0 5

BEARING: S77°E →

8/83

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ANDERSON DAM SPILLWAY ENLARGEMENT

PROJECT NO. SCV-124 A

DATE

FIGURE NO.

GRAPHIC TRENCH LOG

TRENCH NO. T-7A
LOCATION: See Figure III-1
SHEET 1 OF 1
NOTES:

DEPTH	UNITS NO.	UNITS DESCRIPTION	STRUCTURE NO.	STRIKE	DIP	TYPE
THIS LOG INDICATES CONDITIONS IN THIS TEST PIT OR TRENCH ONLY ON THE DATE INDICATED AND MAY NOT REPRESENT CONDITIONS AT OTHER LOCATIONS AND ON OTHER DATES. ANY WATER LEVELS SHOWN ARE SUBJECT TO VARIATION. STRATIFICATION LINES OR DEPTH INTERVALS REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN MATERIAL TYPES AND THE TRANSITIONS MAY BE GRADUAL. SOIL CLASSIFICATIONS SHOWN ON LOG ARE FIELD CLASSIFICATIONS BASED ON THE UNIFIED SOILS CLASSIFICATION SYSTEM.	① ②	Terrace deposit; red brown; varies, beds of clayey sand, clayey sandy gravel, gravelly clayey sand. Serpentine: crushed, sheared; intimately slickensided				

STATION →

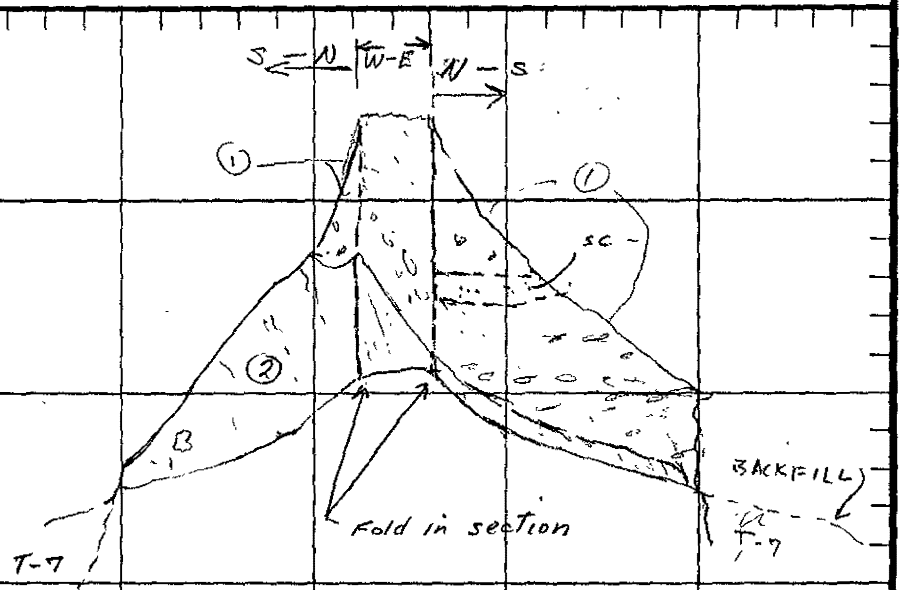
DEPTH (EL.)

6/21/83
DATE

ES
LOGGED BY

0 5
SCALE, FT.

See log
BEARING



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ANDERSON DAM
SPILLWAY ENLARGEMENT

GRAPHIC TRENCH LOG

PROJECT NO. SCV-124A

DATE

FIGURE NO.

TRENCH NO. T-7
SHEET 1 OF 1

LOCATION: See Figure III-1
NOTES:

DEPTH	UNITS NO.	UNITS DESCRIPTION	STRUCTURE NO.	STRIKE	DIP	TYPE
	①	Terrace deposit: red brown; apparently indurated, weakly cemented; clayey sand gravel w/cobbles, few boulders.	1	N 10°E	50° SE	Fracture; red soil
			2	N 10°E	65° SE	Fracture red soil to 1/8".
	②	serpentine: dark; massive, hard, strong.	3	N60° W	78° SW	slickensided fracture.
	③	serpentine: dark; intensely-closely fracture, weak.				
	④	serpentine: dark green, gray, some rust; crushed, intimatly slickensided; appears rock-like, but is soil-like, friable.				

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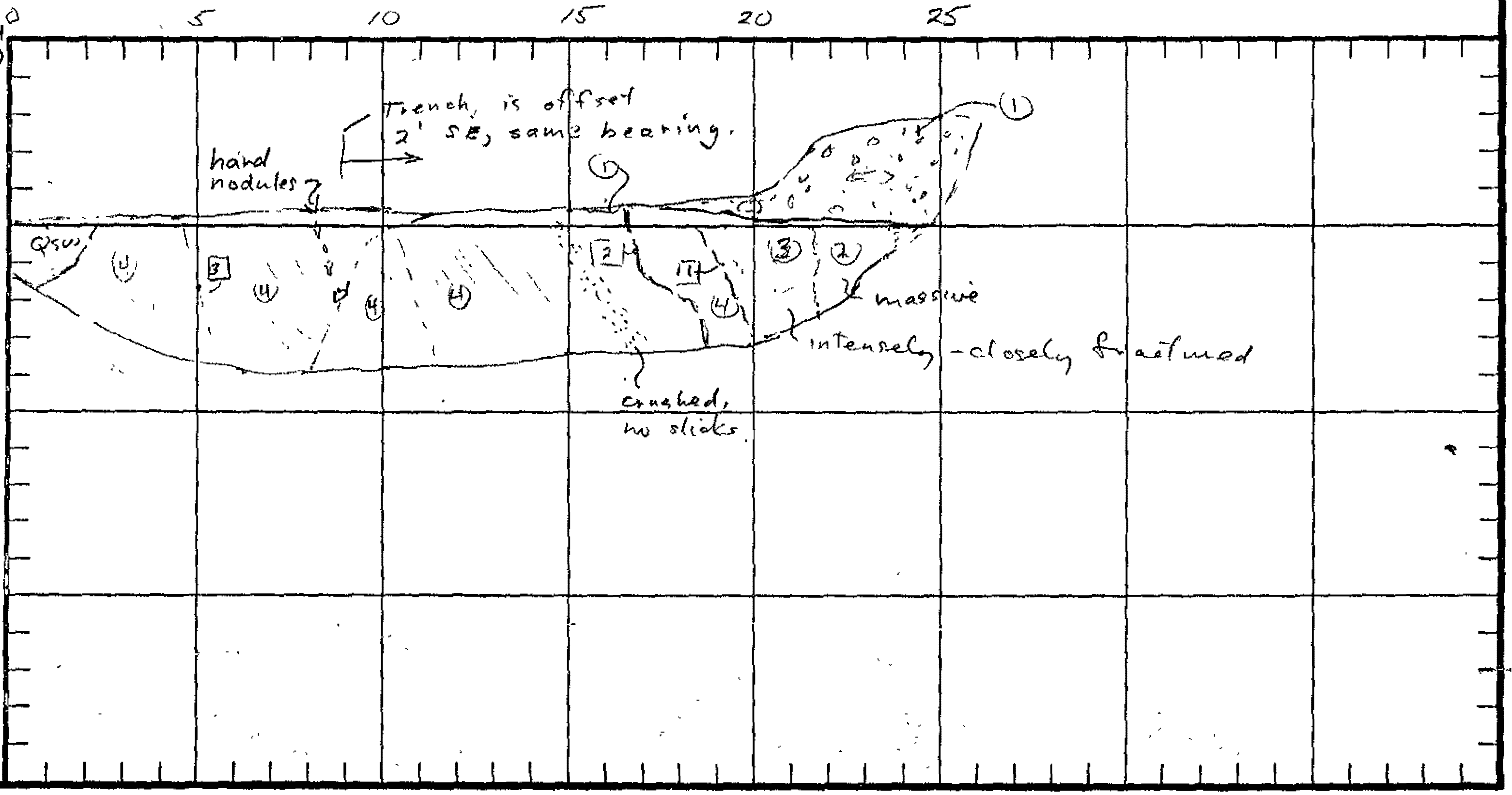
STRATIFICATION LINES OR DEPTH INTERVALS REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN MATERIAL TYPES AND THE TRANSITIONS MAY BE GRADUAL.

SOIL CLASSIFICATIONS SHOWN ON LOG ARE FIELD CLASSIFICATIONS BASED ON THE UNIFIED SOILS CLASSIFICATION SYSTEM.

STATION →

DEPTH (EL.)


0
5
10
15
20
25
Trench is offset 2' SE, same bearing.
hard nodules
①
①
Qsw
④
3
④
④
④
2
1
④
③
②
massive
intensely-closely fractured
crushed, no slicks

6/21/83
DATE

ES
LOGGED BY

0 5
SCALE, FT.

N 75°E
BEARING

6/83

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ANDERSON DAM SPILLWAY ENLARGEMENT

PROJECT NO. SCU-124A

DATE

FIGURE NO.

GRAPHIC TRENCH LOG

TRENCH NO. T-8

SHEET 1 OF 1

LOCATION: See Figure III-1

NOTES: Log of portion of cut slope; typical slope is 63°.

UNITS		
DEPTH	NO.	DESCRIPTION
	(1)	serpentine; sheared, friable, weak; appears rock-like, has rock structure, but is soil-like; light blue gray; intimately slickensided.
	(2)	Terrace deposit 1: brown; clayey sandy gravel w/cobbles, boulders; apparently weakly to moderately cemented in lower portion of section; subrnd.-sub. ang.
	(3)	Terrace deposit: brown; gravelly clayey sand; apparently weakly cemented; 15%-25% gravel; decrease in gravel up section.

STRUCTURE			
NO.	STRIKE	DIP	TYPE
1	N52W	72° NE	Gouge, 1"
2	N75W	74° NE	Gouge, 1/8"-1"
3	N55°W	85 SW	Sheared zone w/ gouge, 2".

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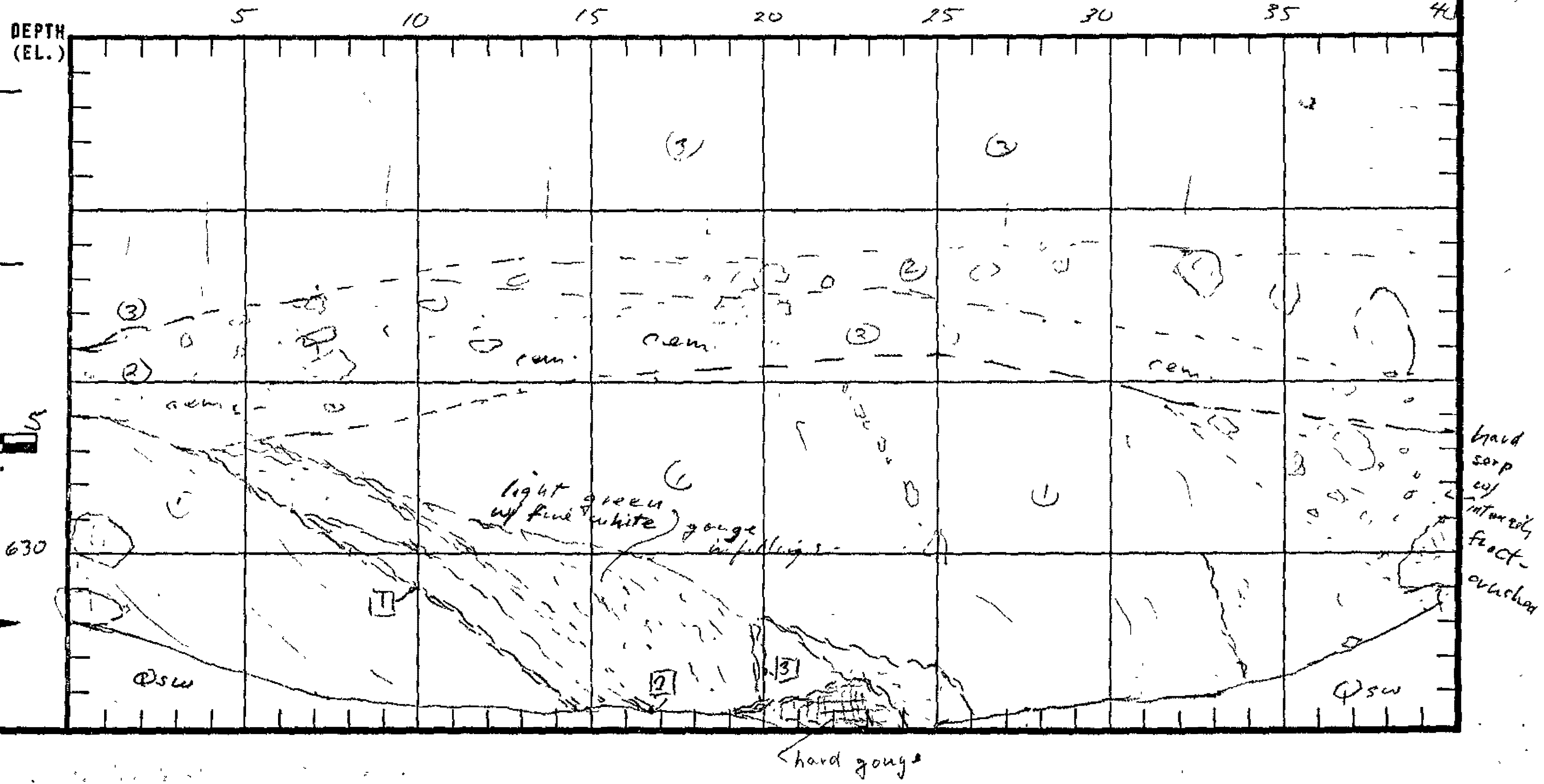
STATION →



6/22/83
DATE

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LOGGED BY

0 5
SCALE, FT.

W - E
BEARING

8/83

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PROJECT NO. SCV-124A

DATE

FIGURE NO.

GRAPHIC TRENCH LOG

TRENCH NO. T-9

SHEET 1 OF 1

LOCATION: See Figure III-1

NOTES: Log of vertical cut made into sloughed cut slope

THIS LOG INDICATES CONDITIONS IN THIS TEST PIT OR TRENCH ONLY ON THE DATE INDICATED AND MAY NOT REPRESENT CONDITIONS AT OTHER LOCATIONS AND ON OTHER DATES. ANY WATER LEVELS SHOWN ARE SUBJECT TO VARIATION.

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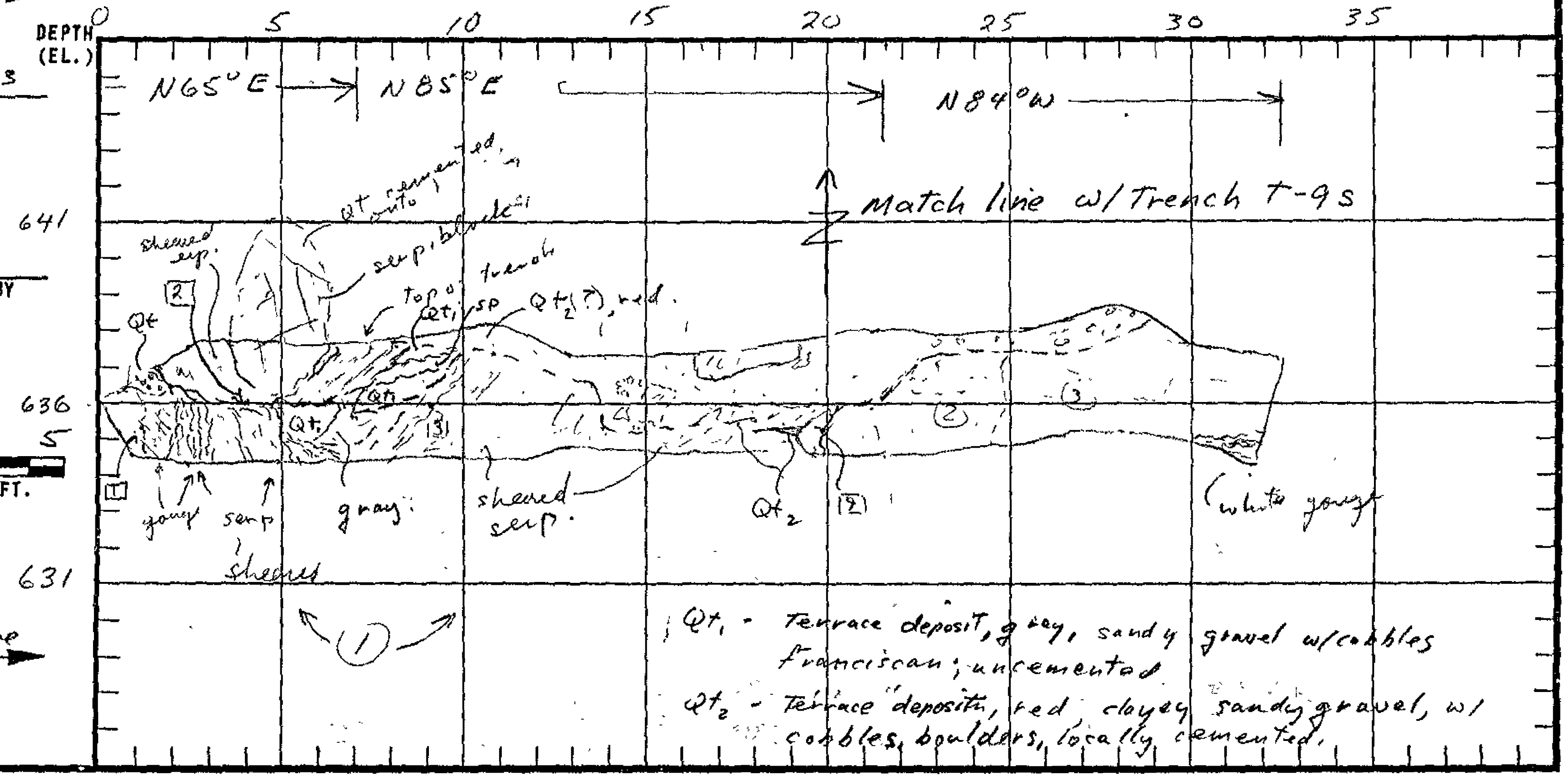
SOIL CLASSIFICATIONS SHOWN ON LOG ARE FIELD CLASSIFICATIONS BASED ON THE UNIFIED SOILS CLASSIFICATION SYSTEM.

UNITS NO.	UNITS DESCRIPTION
①	Serpentine; light-olive green; sheared, soil-like; friable; intimately slicken sided; includes prominent slickensided surfaces, gouge; fault zone.
②	Serpentine: yellow, intensely fractured, weak.
③	Serpentine: light gray green, closely fractured; moderately strong.

STRUCTURE NO.	STRIKE	DIP	TYPE
1	N65°W	90°	Gouge 12" Thick
2	N80°E	62° NW	Slickensided fracture
3	N63E	72 NW	"
4	N60°W	70° SW	Slickensided contact surface

STATION →



Qt₁ - Terrace deposit, gray, sandy gravel w/cobbles Franciscan; uncemented

Qt₂ - Terrace deposits, red clayey sandy gravel, w/ cobbles, boulders, locally cemented.

6/23/83
DATE

ES
LOGGED BY

0 5
SCALE, FT.

See above
BEARING

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GRAPHIC TRENCH LOG

PROJECT NO SCV-124A

DATE

FIGURE NO.

TRENCH NO. T-9S

SHEET 1 OF 1

LOCATION: See Figure III-1

NOTES: Log of vertical slope above T-9

UNITS			STRUCTURE			
DEPTH	NO.	DESCRIPTION	NO.	STRIKE	DIP	TYPE
THIS LOG INDICATES CONDITIONS IN THIS TEST PIT OR TRENCH ONLY ON THE DATE INDICATED AND MAY NOT REPRESENT CONDITIONS AT OTHER LOCATIONS AND ON OTHER DATES ANY WATER LEVELS SHOWN ARE SUBJECT TO VARIATION. STRATIFICATION LINES OR DEPTH INTERVALS REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN MATERIAL TYPES AND THE TRANSITIONS MAY BE GRADUAL SOIL CLASSIFICATIONS SHOWN ON LOG ARE FIELD CLASSIFICATIONS BASED ON THE UNIFIED SOILS CLASSIFICATION SYSTEM.	① ②	SLOPEWASH: GRAVELLY CLAYEY SAND; dark red brn.; ang.-sub. ang. fine-cse. gravel; appears to be loose, uncemented. TERRACE DEPOSIT: GRAVELLY CLAYEY SAND: red. brn.; appears indurated or weakly cemented (Qt_2)				

8/11/83
DATE

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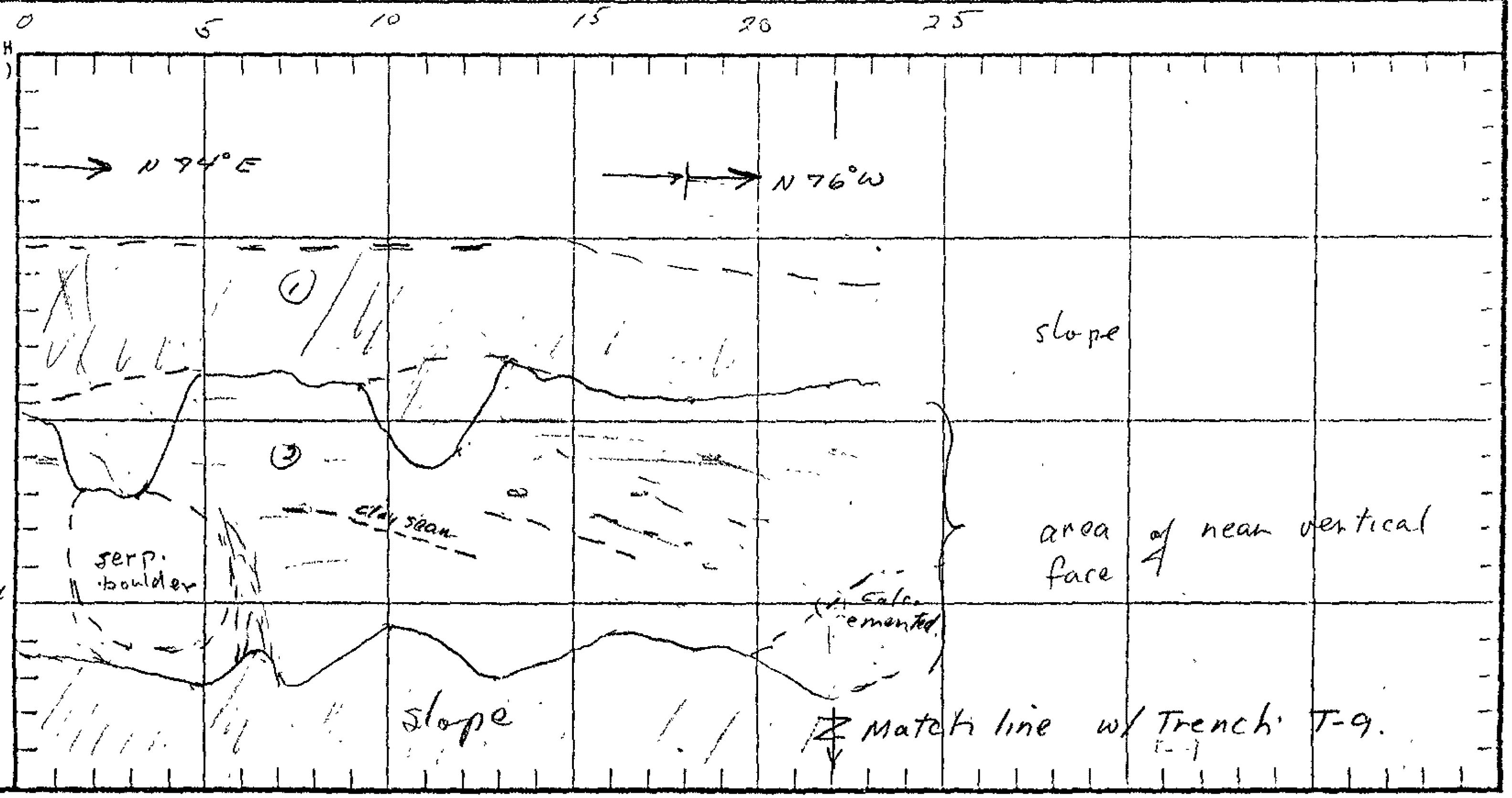
SCALE, FT.

See Log
BEARING



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GRAPHIC TRENCH LOG

PROJECT NO. SCV-124A
DATE
FIGURE NO.

TRENCH NO. T-10
SHEET 1 OF 1
LOCATION: See Figure III - 2
NOTES:

UNITS			STRUCTURE			
DEPTH	NO.	DESCRIPTION	NO.	STRIKE	DIP	TYPE
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STATION →

DEPTH (EL.)

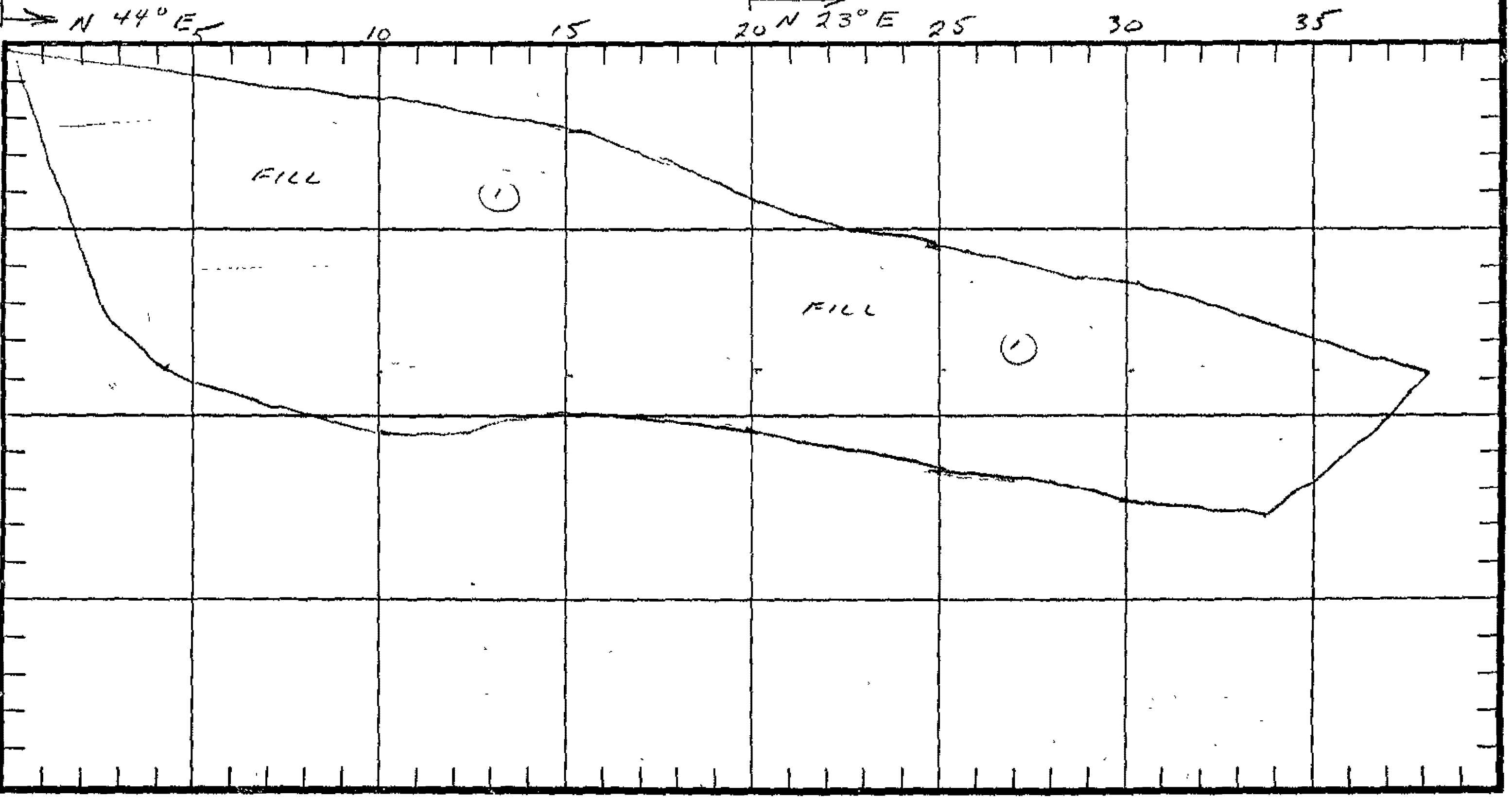
7/11/83
DATE

ES
LOGGED BY

5
10
15

0 5
SCALE, FT.

See Above
BEARING →



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GRAPHIC TRENCH LOG

PROJECT NO. SCV-124A

DATE

FIGURE NO.

TRENCH NO. T-11

SHEET 1 OF 1

LOCATION: See Figure II-2

NOTES:

DEPTH	UNITS NO.	UNITS DESCRIPTION	STRUCTURE NO.	STRIKE	DIP	TYPE
	①	FILL/ Gravelly Silty Sand (SM): gray; non plastic, derived largely from serpentine; some cobbles.	Samples B-1	- 4'	- 8'	colluvial(?) soils.
	②	FILL/ Gravelly Clayey Sand (SC): med. dk. brown; med. plastic fines; moist.	B-2	0'	4"	fill
	③	TERRACE DEPOSIT/ clayey sand (SC); med. brn; slightly plastic fines; moist; some fine gravel, contains serp. and Franciscan detritus.				
	④	TERRACE DEPOSIT/sandy clay (CL): dk. brn; some dessication structure, mottled; moist.				

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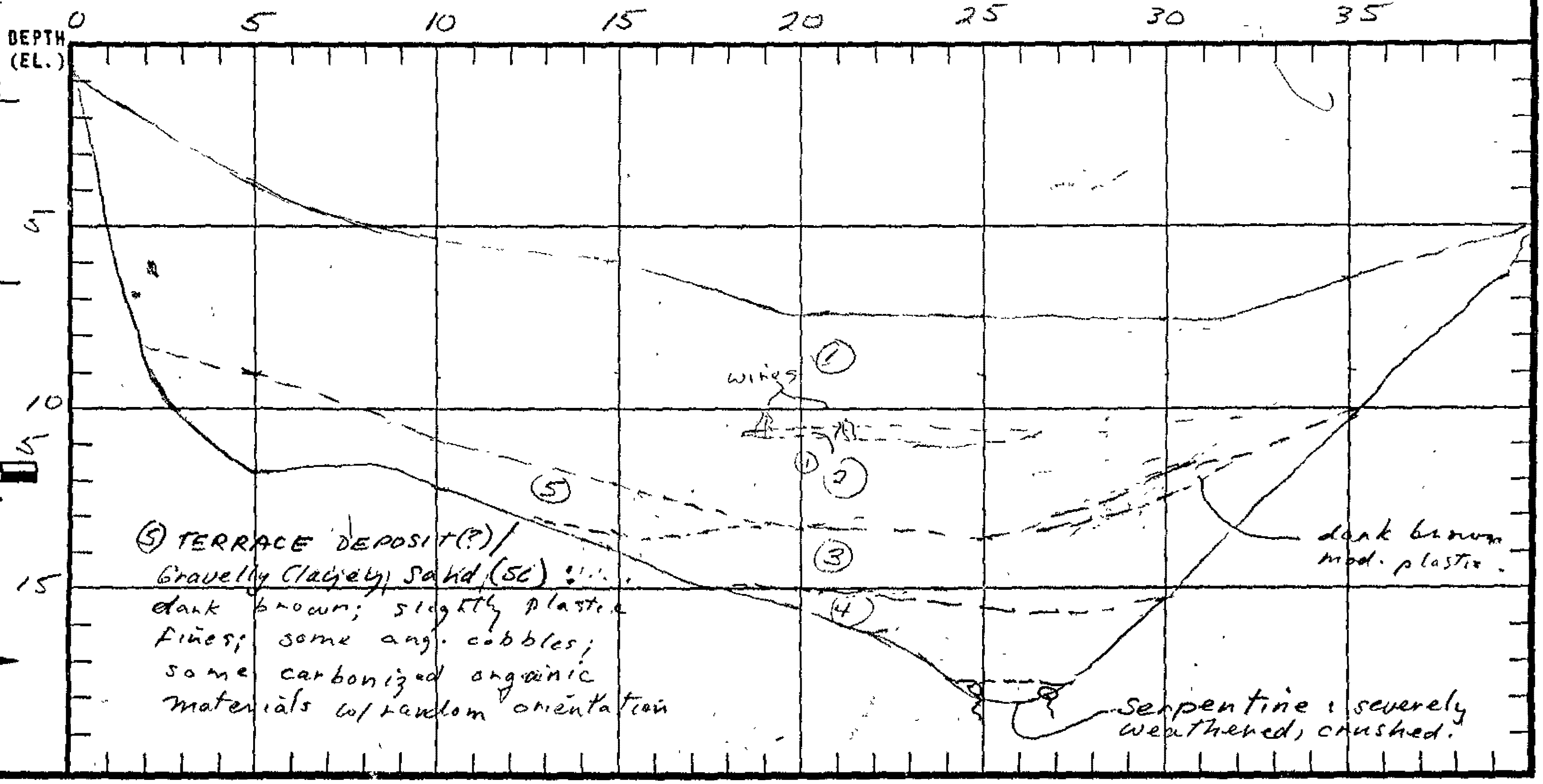
SOIL CLASSIFICATIONS SHOWN ON LOG ARE FIELD CLASSIFICATIONS BASED ON THE UNIFIED SOILS CLASSIFICATION SYSTEM.

7/11/83
DATE

ES
LOGGED BY

0 5
SCALE, FT.

N 40°E
BEARING



⑤ TERRACE DEPOSIT(?)/ Gravelly Clayey Sand (SC): dark brown; slightly plastic fines; some ang. cobbles; some carbonized organic materials w/ random orientation

dark brown mod. plastic.

Serpentine: severely weathered, crushed.

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SPILLWAY ENLARGEMENT

PROJECT NO. SCV-124 A
DATE
FIGURE NO.

GRAPHIC TRENCH LOG

TRENCH NO. T-12
SHEET 1 OF 1
LOCATION: See Figure III-2
NOTES:

UNITS		STRUCTURE			
NO.	DESCRIPTION	NO.	STRIKE	DIP	TYPE
①	Fill / Silty Sand: Tan; non plastic fines.				
②	Colluvium / Clayey Sand - Sandy Clay (SC-CL); moist to wet; dark brown; some gravel, rare cobbles; contains some roots.				
③	TERRACE DEPOSIT / Gravelly clayey sand (SC); wet; red brown; below zone of seepage				

DEPTH

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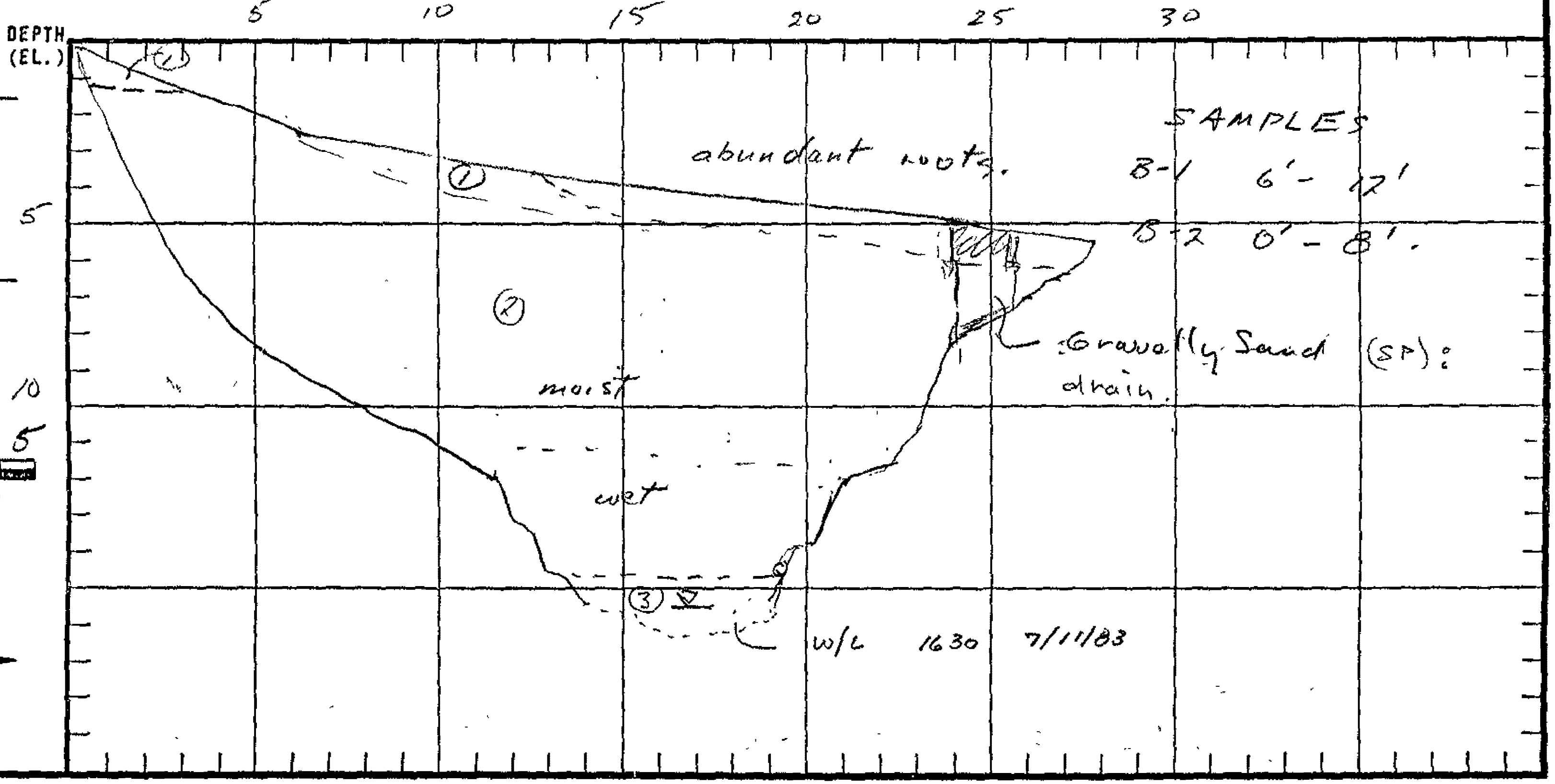
DATE 7/11/83

LOGGED BY ES

SCALE, FT. 0 5

BEARING N 15° E



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SPILLWAY ENLARGEMENT

PROJECT NO. SCV-124A

DATE

FIGURE NO.

GRAPHIC TRENCH LOG

TRENCH NO. T-13

SHEET 1 OF 1

LOCATION: See Figure III-2

NOTES:

DEPTH	UNITS NO.	UNITS DESCRIPTION	STRUCTURE NO.	STRIKE	DIP	TYPE
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	②	TERRACE DEPOSIT / Sandy Clay: med. brown, slightly reddish; moist; plastic fines; contains cobbles; some internal slicks; some roots.	B-2	0'-8'		
	③	FILL / Sandy Clay - Clayey Sand: dark brown.				

STATION →

7/12/83
DATE

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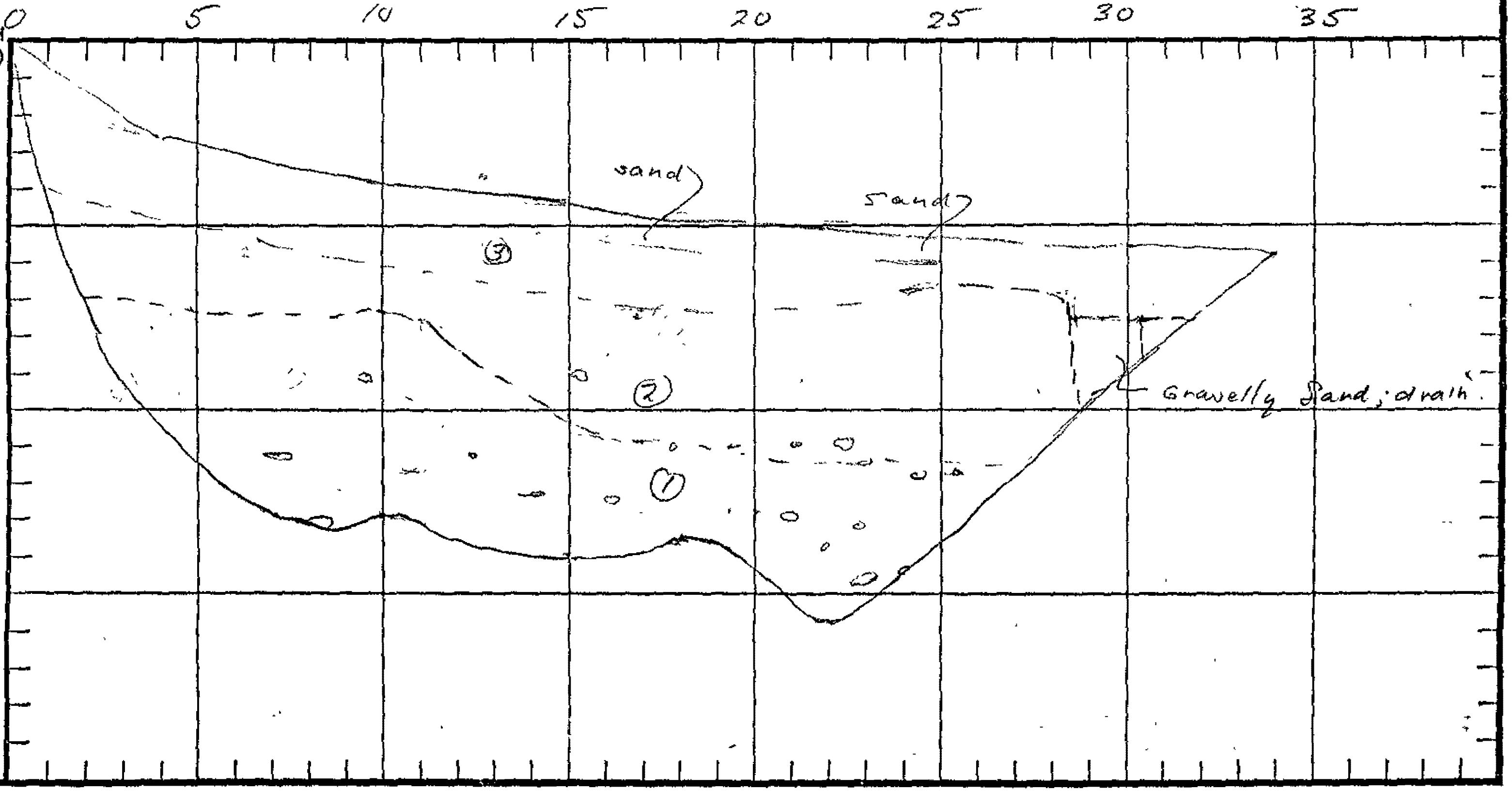
LOGGED BY

0 5
SCALE, FT.

N15W
BEARING →

DEPTH (EL.)



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SPILLWAY ENLARGEMENT

PROJECT NO. SCV-124A

DATE

FIGURE NO.

GRAPHIC TRENCH LOG

TRENCH NO. T-14

SHEET 1 OF 1

LOCATION: See Figure III-2

NOTES:

UNITS			STRUCTURE			
DEPTH	NO.	DESCRIPTION	NO.	STRIKE	DIP	TYPE
	①	Colluvium: Clayey Sand (SC) w/ cobbles; dark brown; slightly damp; abundant ang.-sub. ang. sandstone cobbles; probably Recent.	1	N 30° W	30° SW	joint
	②	Colluvium: Gravelly Clayey Sand; dark brown moist, contains angular fragments of weathered sandstone, shale to coarse gravel.		N 20° E	67° SE	joint.
	③	Franciscan Fm: Sheared Shale w/ some sandstone; gray brown; soil-like; weak, friable; damp, plastic.				

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STATION ⟶

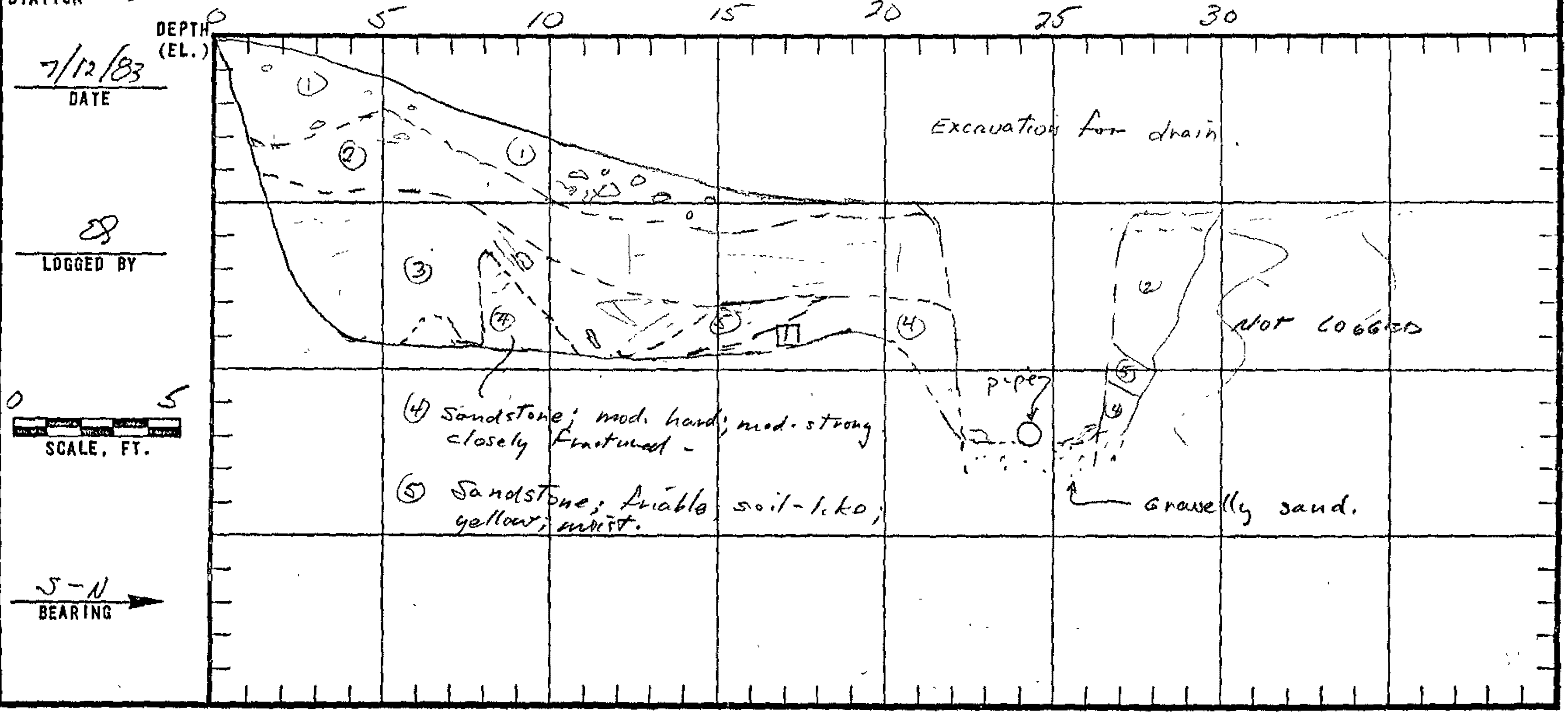
DEPTH (EL.)

7/12/83
DATE

CB
LOGGED BY

SCALE, FT.

S-N
BEARING



④ Sandstone; mod. hard; mod. strong closely fractured -

⑤ Sandstone; friable, soil-like; yellow; moist.

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PROJECT NO. SCV-124A

DATE

FIGURE NO.

GRAPHIC TRENCH LOG

TRENCH NO. T-15

SHEET 1 OF 1

LOCATION: See Figure III-2

NOTES:

DEPTH	UNITS NO.	UNITS DESCRIPTION	STRUCTURE NO.	STRIKE	DIP	TYPE
	①	COLLUVIUM / sandy clay (CL-CH): dark brown; damp-moist; some gravel, cobbles, roots.		SAMPLES		
			B-1	serpentine, Sta 3'-5'.		4-11,
	②	TERRACE DEPOSIT / gravelly clayey sand (SC): yellow brown; contains cobbles of serp., sandstone; slightly - mod. plastic fines; cobbles concentrated in upper 1'.	B-2	terrace	deposit	, 3'-6'
			B-3	Sta. 20 colluvium	- 30, 0'-3'	
	③	SERPENTINE: Sheared; altered; generally soil-like.				

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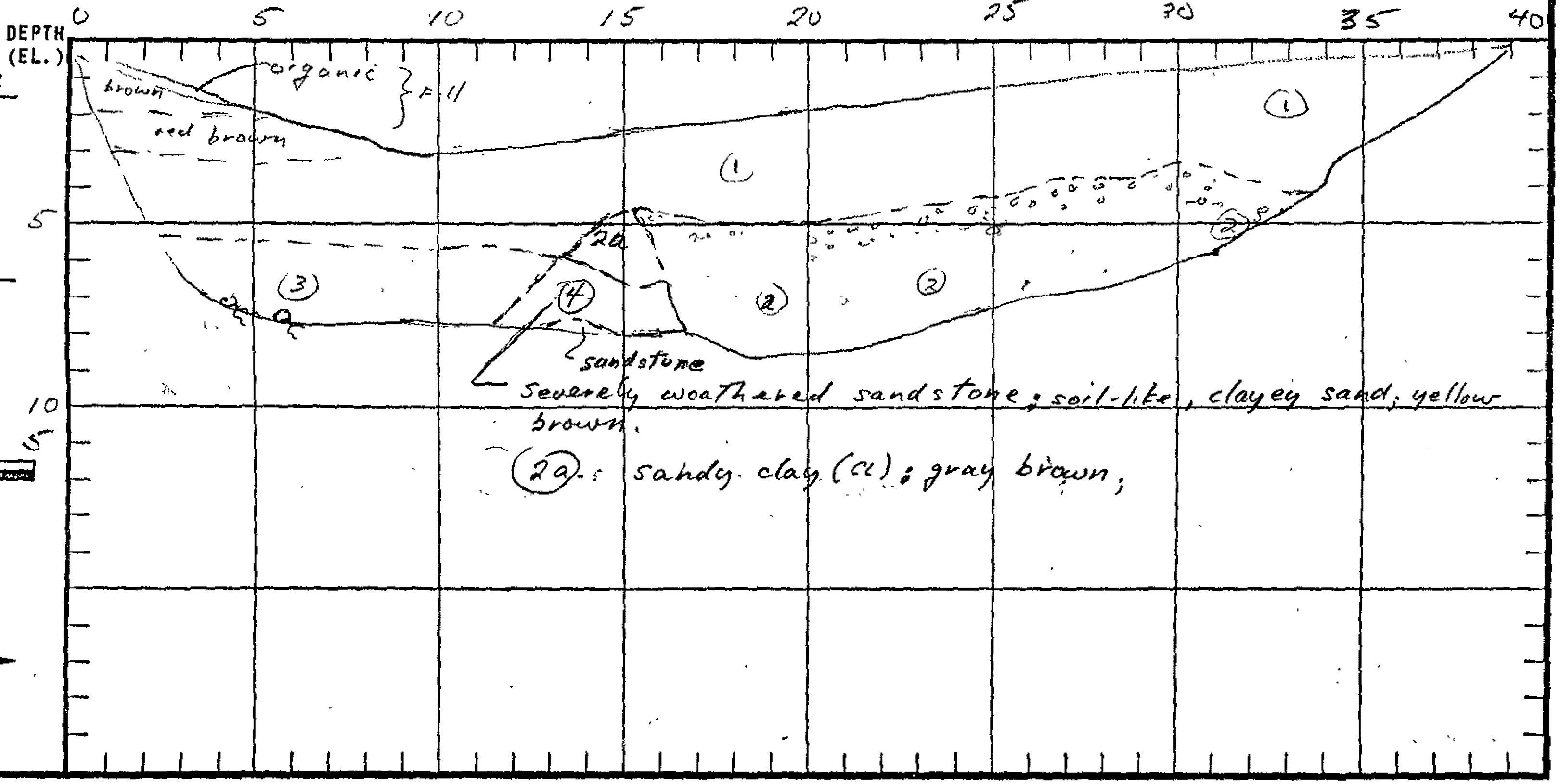
STATION ⟶

DATE: 7/12/83

LOGGED BY: ES

SCALE, FT.: 0 – 5

BEARING: N43°E ⟶



④ Severely weathered sandstone; soil-like, clayey sand; yellow brown.

②a: sandy clay (CL); gray brown;

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PROJECT NO. SCV-124A

GRAPHIC TRENCH LOG

DATE

FIGURE NO.

TRENCH NO. T-16 LOCATION: See Figure III-2

SHEET 1 OF 1 NOTES:

UNITS			STRUCTURE			
DEPTH	NO.	DESCRIPTION	NO.	STRIKE	DIP	TYPE
0'-4'	①	COLLUVIUM / SANDY CLAY (CL-CH); v. dark brown; 10%-20% sand, fine-cse.; some gravel; internal slicks; highly plastic; suspect expansive; damp-moist.				
3'-6'	②	COLLUVIUM / SANDY CLAY (CL-CH): grey brown; 20%-30% sand, fine-cse.; some gravel; highly plastic; moist.				
5'-8½'	③	TERRACE DEPOSIT/CLAYEY SAND (SC): yel. brn.; 15%-20% fines, slightly plastic, plasticity, fines decrease w/ depth. weakly cemented; med.-cse. sand.				

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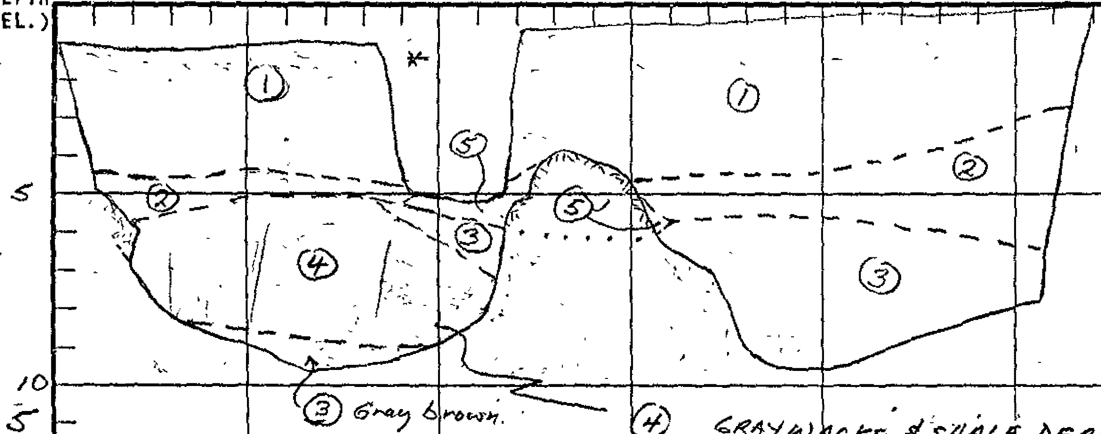
STRATIFICATION LINES OR DEPTH INTERVALS REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN MATERIAL TYPES AND THE TRANSITIONS MAY BE GRADUAL.

SOIL CLASSIFICATIONS SHOWN ON LOG ARE FIELD CLASSIFICATIONS BASED ON THE UNIFIED SOILS CLASSIFICATION SYSTEM.

STATION → → N 85°E 5 10 → N 70°E 20 25 30

DEPTH (EL.)



SAMPLES		
NO.	LOCATION	DEPTH
B-1	Sta. 20	5'-7.5'

7/13,15/83
DATE

ES
LOGGED BY

0 5
SCALE, FT.

See above
BEARING

④ GRAYWACKE & SHALE DEBRIS: disturbed; angular fragments and fractured blocks of sandstone and shale; fractures have unit ③ in filling; talus or slumped blocks (?) overlying unit ③.

*-Excavation for T-18.

⑤ SERPENTINE BOULDER: massive.

6/83

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PALO ALTO ● NEWPORT BEACH ● DENVER

ANDERSON DAM
SPILLWAY ENLARGEMENT

PROJECT NO. SCV-124 A

DATE

FIGURE NO.

GRAPHIC TRENCH LOG

TRENCH NO. T-17

SHEET 1 OF 2

LOCATION: See Figure III-2

NOTES:

UNITS			STRUCTURE			
DEPTH	NO.	DESCRIPTION	NO.	STRIKE	DIP	TYPE
	①	FILL/ GRAVELLY SANDY CLAY: gray, brown; slightly damp;	1	N-S N 86°W	90° 67° NE	joint joint
	②	TERRACE DEPOSIT/ CLAYEY SAND: tan; moist; 10%-30% fines, slightly plastic; some gravelly lenses;	2	–	15°	apparent dip on pebble layer
	③	COLLUVIUM/SANDY CLAY: dark brown; damp; highly plastic; some gravel	3	N 30°W	85° NE	joint w/ some dark stain.
	④	FRANCISCAN FM/ GRAYWACKE: mod. hard; mod. strong.				

STATION →

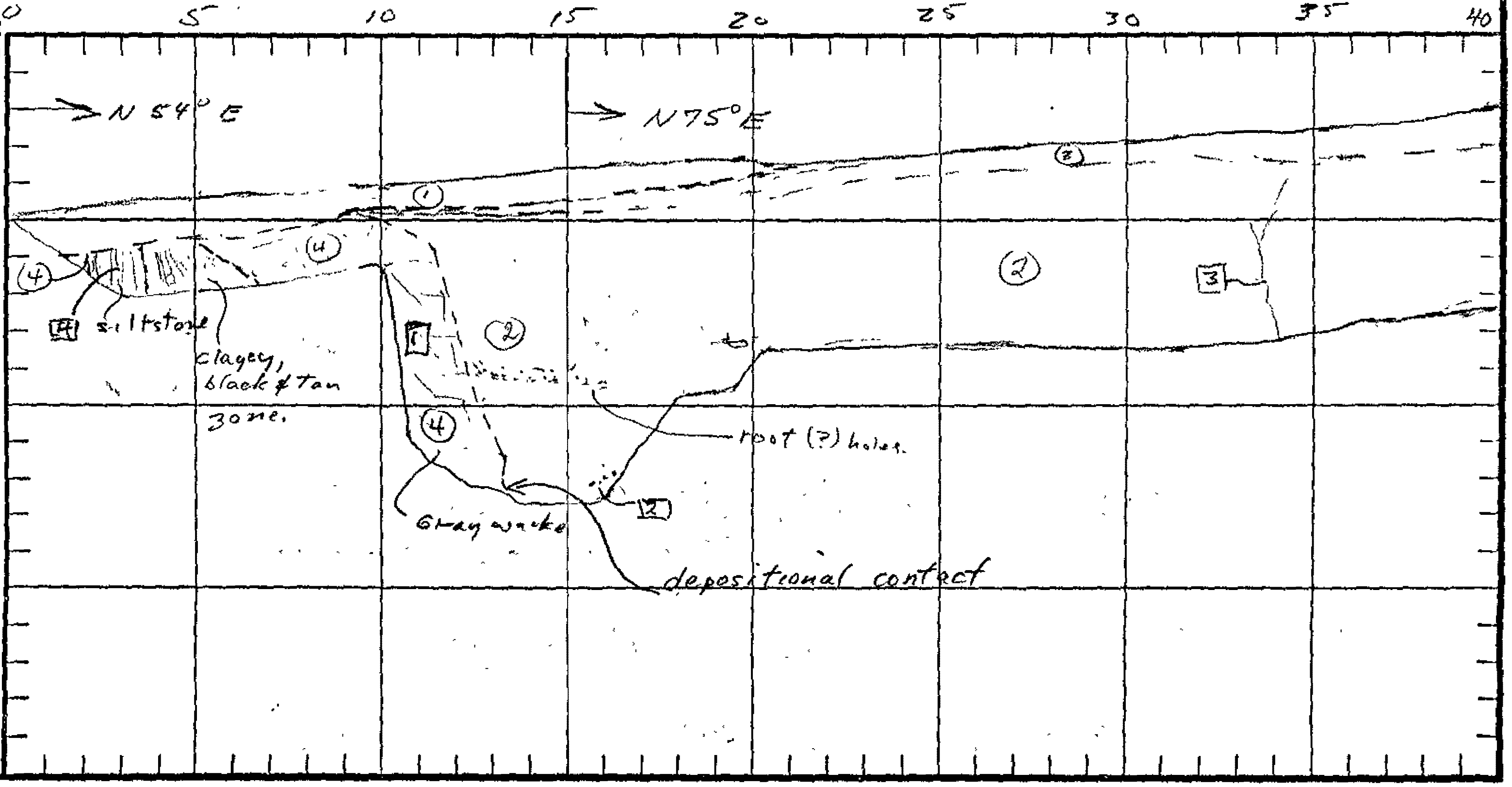
DEPTH (EL.)

7/14/83
DATE

ES
LOGGED BY

0 5
SCALE, FT.

See log
BEARING →



6/4

6/83

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GRAPHIC TRENCH LOG

PROJECT NO. SCV-124A

DATE

FIGURE NO.

TRENCH NO. T-17

SHEET 2 OF 2

LOCATION:

NOTES:

UNITS			STRUCTURE			
DEPTH	NO.	DESCRIPTION	NO.	STRIKE	DIP	TYPE
	(4)	FRANCISCAN FM: GRAYWACKE: (cont'd); intensely-closely fractured; excavated w/difficulty.	4	N 45°W	85°NE	bedding in shale.
				SAMPLES		
			B-1	Sta. 10±	1-5'.	

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STATION ⟶

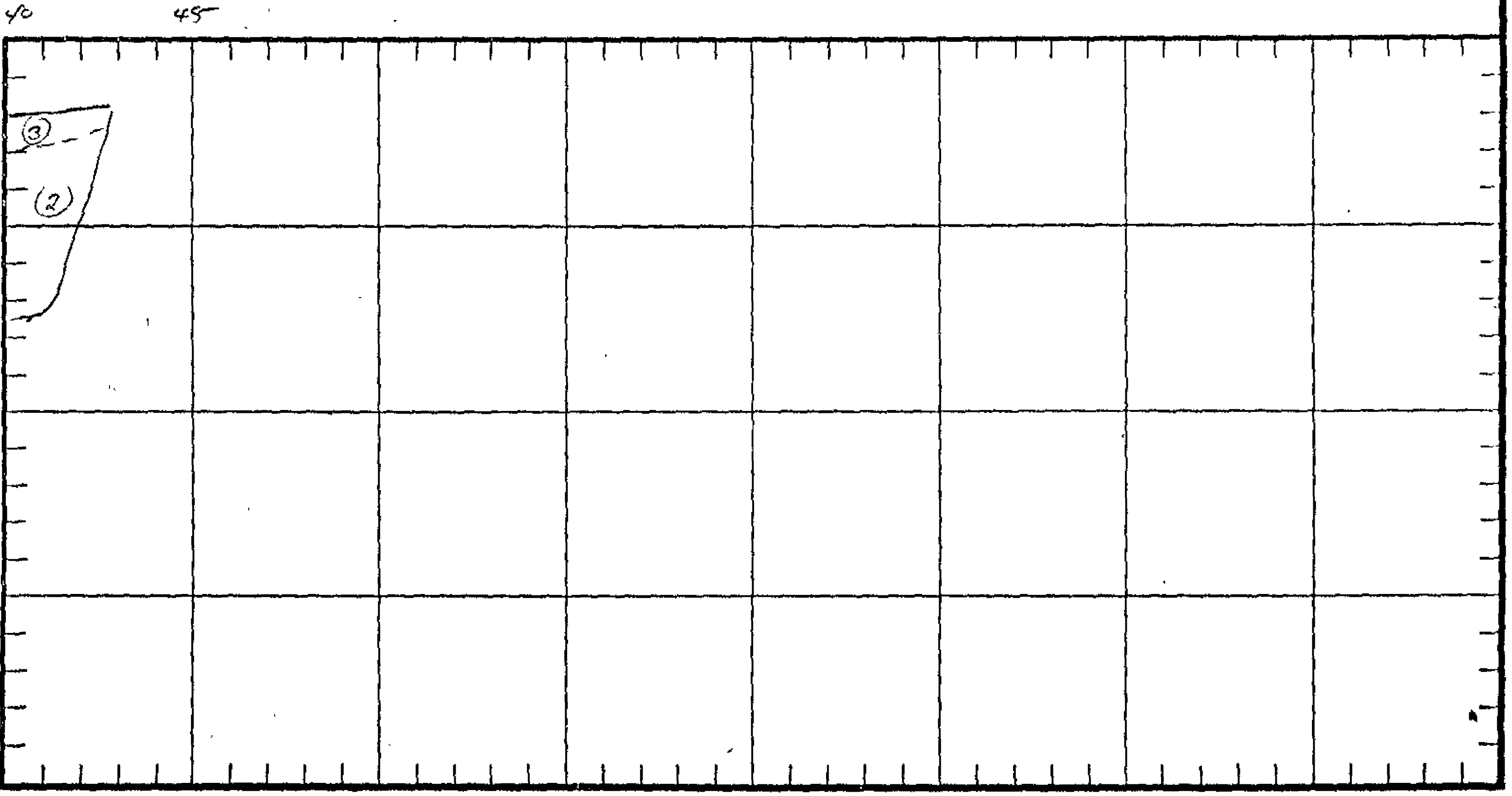
DEPTH (EL.)

DATE

LOGGED BY

SCALE, FT.

BEARING ⟶



6/83

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ANDERSON DAM
SPILLWAY ENLARGEMENT

TRENCH NO. T-18
SHEET 1 OF 1
LOCATION: See Figure III-2
NOTES:

UNITS			STRUCTURE			
DEPTH	NO.	DESCRIPTION	NO.	STRIKE	DIP	TYPE
0.0-4.0	①	COLLUVIUM / SANDY CLAY; v. dark brown - brown; damp - v. moist; exc. in chunks in upper 3'; 10%-15% sand, fine; highly plastic (CL-CH).				
	②	TERRACE DEPOSIT / GRAVELLY SANDY CLAY; med. brown; moist; 10%-20% gravel, ang.-sub. ang.; 20%-30% sand, fine-cse.; mod. plastic (CL); some cobbles.				
	③	TERRACE DEPOSIT / GRAVELLY CLAYEY SAND; med. brown; moist; 5%-10% gravel, fine; sub.ang.; 25%-35% fines, slightly plastic (SC).				

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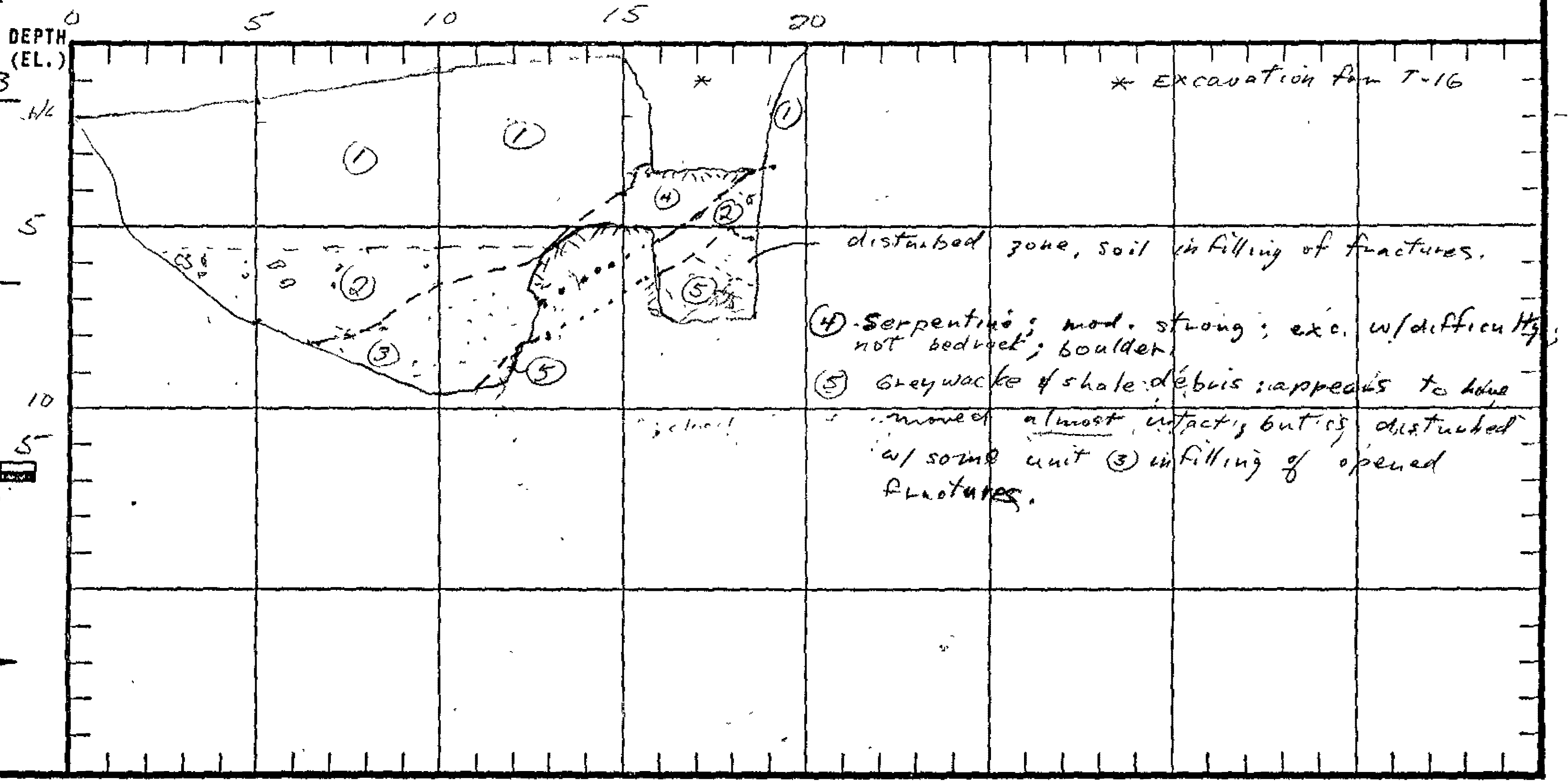
STATION →

7/15/83
DATE

ES
LOGGED BY

0 5
SCALE, FT.

N-S →
BEARING



* Excavation for T-16

disturbed zone, soil infilling of fractures.

④ Serpentine; mod. strong; exc. w/difficulty; not bedrock; boulder.

⑤ Greywacke & shale débris; appears to have moved almost intact, but is disturbed w/ some unit ③ infilling of opened fractures.

GRAPHIC TRENCH LOG

PROJECT NO. SCV-124A

DATE

FIGURE NO.

8/83

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ANDERSON DAM SPILLWAY ENLARGEMENT

GRAPHIC TRENCH LOG

PROJECT NO. SCV-124A

DATE

FIGURE NO.

TRENCH NO. T-19

SHEET 1 OF 2

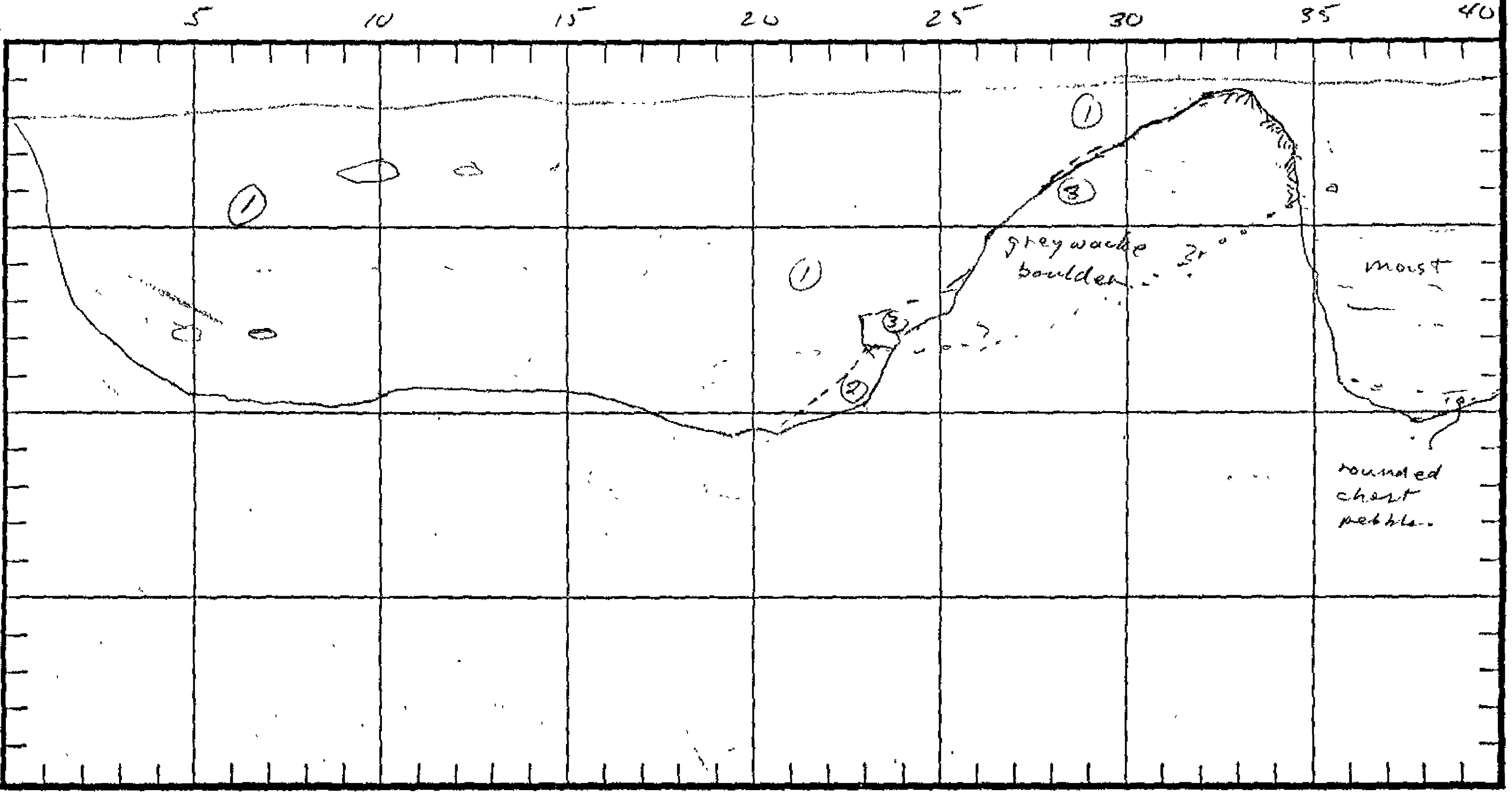
LOCATION: See Figure III-2

NOTES: Sta. 0 - Sta 28 sketched from surface, loose ground.

UNITS			STRUCTURE			
DEPTH	NO.	DESCRIPTION	NO.	STRIKE	DIP	TYPE
	①	FILL: GRAVELLY CLAYEY SAND: grey, brown; damp-moist; largely derived from serpentine, contains cobbles, boulders of serpentine, graywacke; moist below .5'.				
	②	GRAVELLY SANDY CLAY: red brown; moist.				
	③	GRAYWACKE BOULDER: massive; hard.				

STATION →

DEPTH (EL.)



7/15/83
DATE

ES
LOGGED BY

0 5
SCALE, FT.

N 60° E
BEARING

8/83

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TRENCH NO. T-19
SHEET 2 OF 2
LOCATION: See Figure III-2
NOTES:

UNITS			STRUCTURE			
DEPTH	NO.	DESCRIPTION	NO.	STRIKE	DIP	TYPE
	④	COLLUVIUM / GRAVELLY SANDY CLAY: dark brown; damp - moist; 10%-20% gravel; highly plastic (CL-CH).				
	⑤	TERRACE DEPOSIT / ": GRAVELLY CLAYEY SAND: yellow brown; damp; 20%-30% gravel; 15%-30% fines, slightly plastic; (SC); subrnd.-sub ang.				
	⑥	TERRACE DEPOSIT / SANDY CLAY: dark brown-red brown; contains pocket of roots, organic mat'ls-,				

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SOIL CLASSIFICATIONS SHOWN ON LOG ARE FIELD CLASSIFICATIONS BASED ON THE UNIFIED SOILS CLASSIFICATION SYSTEM.

STATION ⟶

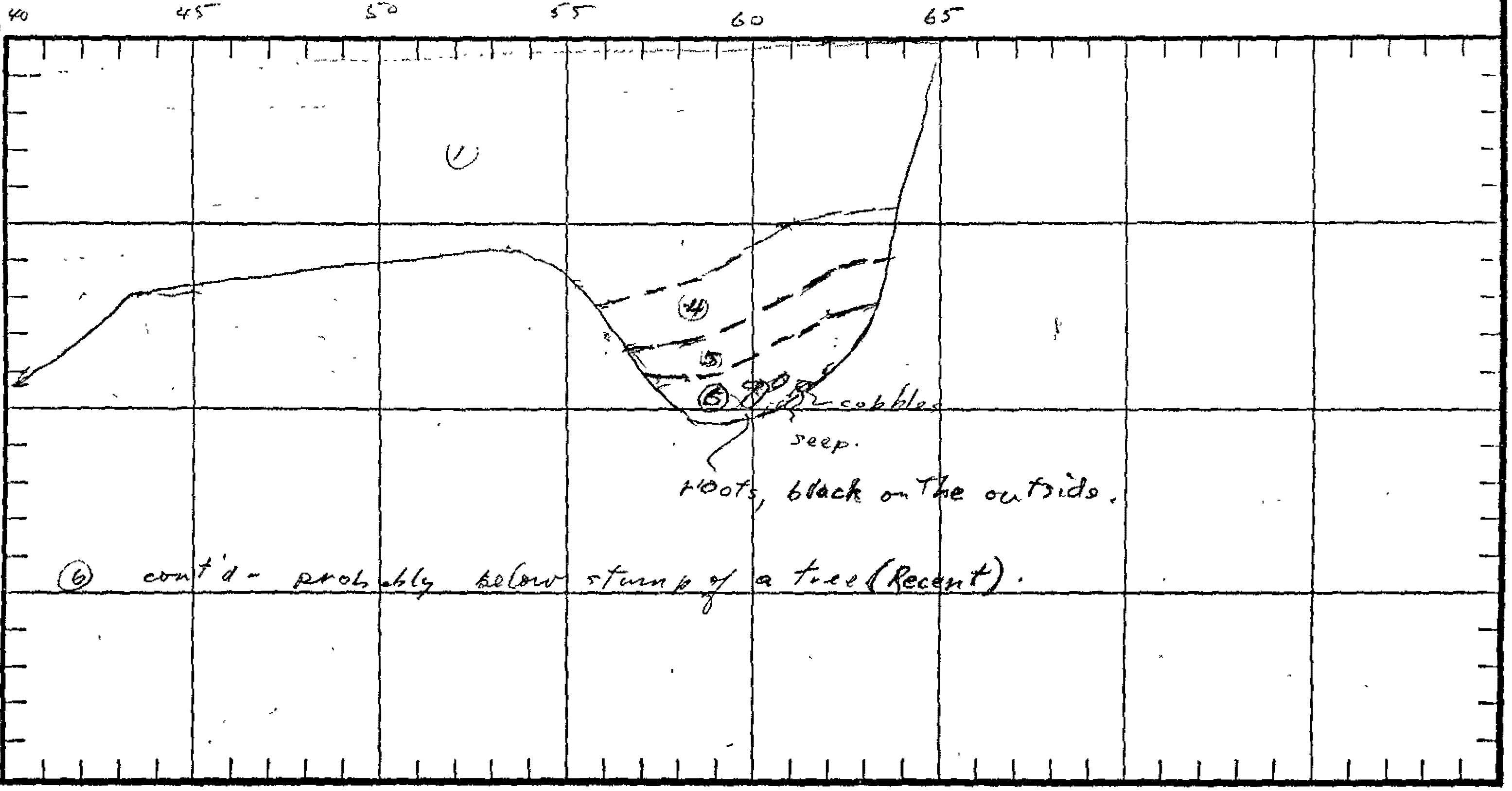
DEPTH (EL.)

DATE: 7/15/83

LOGGED BY: ES

SCALE, FT. 0 – 5

BEARING ⟶



⑥ cont'd - probably below stump of a tree (Recent).

GRAPHIC TRENCH LOG

PROJECT NO.

DATE

FIGURE NO.

8/83

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ANDERSON DAM
SPILLWAY ENLARGEMENT

PALO ALTO ● NEWPORT BEACH ● DENVER

GRAPHIC TRENCH LOG

PROJECT NO. SCU-124A

DATE

FIGURE NO.

TRENCH NO. T-20

SHEET 1 OF 1

LOCATION: See Figure III-2

NOTES: Trench sketched from surface, loose ground.

DEPTH	UNITS NO.	UNITS DESCRIPTION	STRUCTURE NO.	STRIKE	DIP	TYPE
	①	FILL/ GRAVELLY CLAYEY SAND: brown and red; moist - v. moist; 10% - 30% gravel, fine-cse; slightly - mod. plastic fines, 20% - 30%, (SC).				
	②	TERRACE DEPOSIT/CLAYEY SAND: red brown; v. moist - wet; 25%-35% fines, slightly plastic; fine-med. sand; some gravel, sub.ang.; (SC).				
	③	TERRACE DEPOSIT/ SANDY GRAVEL W/COBBLES: gray; fine to cse. gravel, rnd.-sub rnd.; mostly sandstone some serp.				

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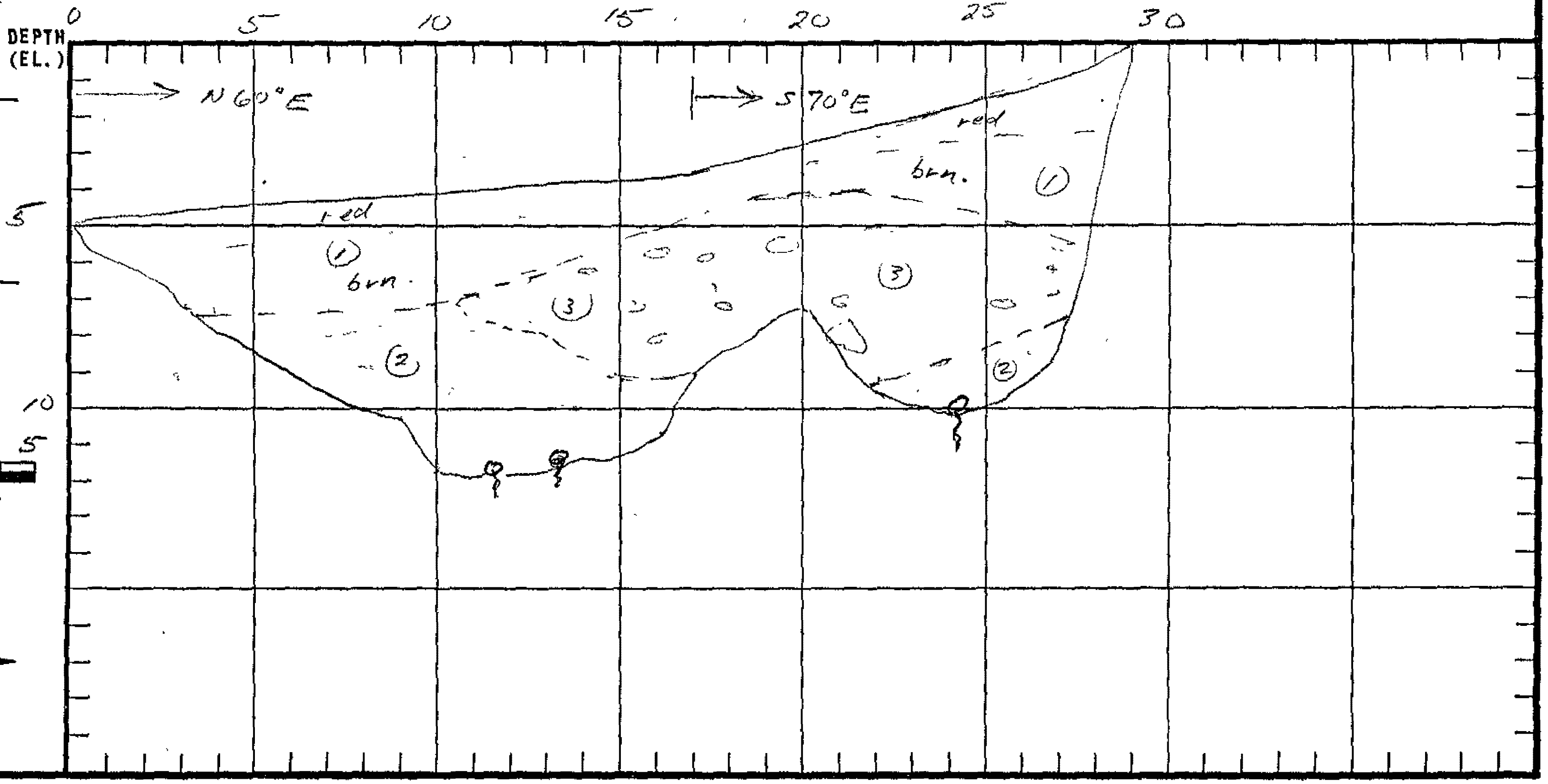
STATION →

DEPTH (EL.)

DATE 7/15/83

LOGGED BY ES



SCALE, FT. 0 5

BEARING →

8/83

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ANDERSON DAM SPILLWAY ENLARGEMENT

PROJECT NO. SCV-124A

DATE

FIGURE NO.

GRAPHIC TRENCH LOG

TRENCH NO. T-21

SHEET 1 OF 1

LOCATION: See Figure III-2

NOTES:

THIS LOG INDICATES CONDITIONS IN THIS TEST PIT OR TRENCH ONLY ON THE DATE INDICATED AND MAY NOT REPRESENT CONDITIONS AT OTHER LOCATIONS AND ON OTHER DATES. ANY WATER LEVELS SHOWN ARE SUBJECT TO VARIATION.

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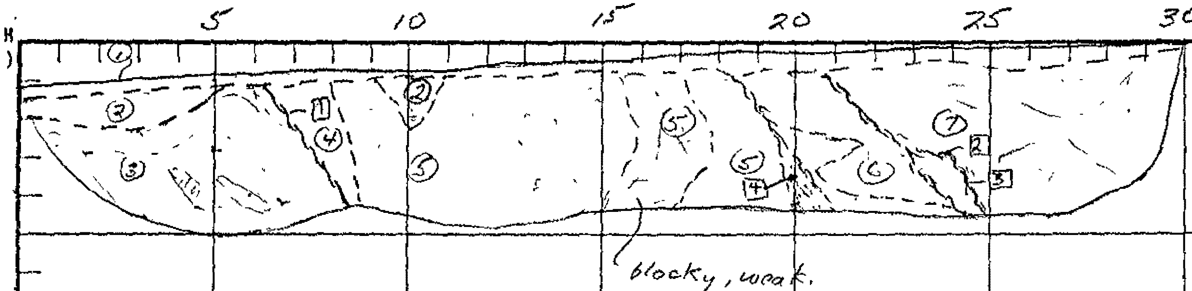
UNITS			STRUCTURE			
DEPTH	NO.	DESCRIPTION	NO.	STRIKE	DIP	TYPE
	①	Surface soil: clayey sand (SC); light red brown; probably construction remnant; contains roots.	1	E-W	56° N	Fault contact.
	②	Terrace Deposit (Old Alluvium) / Sandstone; tan; friable; contains some sub rnd. mixed Franciscan gravel, cse. sand.	2	N40°E	65° NW	fault
	③	Franciscan Fm / Greenstone: green and dark red brown; crushed; sheared; soil-like; clayey; abundant slicks; fault zone; largely gouge	3	N70°E	75° NW	fault
				slicks plunge down dip.		
	④	Graywacke; light gray; crushed; soil like; contains nodules of hard graywacke.	4	N60°E	70° NW	fault.

STATION ⟶

DEPTH (EL.)



8/10/83
DATE

ES
LOGGED BY

⑤ Greenstone; tan w/ red mottling; crushed, greenstone breccia; friable; soil-like; clayey sand; fault zone.

⑥ Serpentine; green; soil-like; sheared w/ internal slicks.

⑦ Graywacke: tan-gray brown; hard blocks, nodules w/ crushed areas; fault zone.

0 5
SCALE, FT.

N 24 E ⟶
BEARING

8/83

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PROJECT NO. SCV-124A
DATE
FIGURE NO.

GRAPHIC TRENCH LOG

TRENCH NO. T-22
SHEET 1 OF 1
LOCATION: See Figure III-2
NOTES:

UNITS			STRUCTURE			
DEPTH	NO.	DESCRIPTION	NO.	STRIKE	DIP	TYPE
	①	TERRACE DEPOSIT (older Alluvium)/Clayey sandy Gravel: light brown w/ some dark brown stain on gravels; moist-wet; 60%-80% gravel, fine-coarse; rnd.-subrnd.; 5%-10% fines, slightly plastic; poorly indurated; some roots to 0.5'.	I	N 40° W	85° SW	fault
	②	TERRACE DEPOSIT/ Clayey Sand: light gray brown, tan; moist, 35%-40% fines, mod. plastic; fine-med. sand.				
	③	TERRACE DEPOSIT Cobbles, coarse gravel w/ clayey sandy gravel matrix; gray brown; rounded graywacke cobbles common.				

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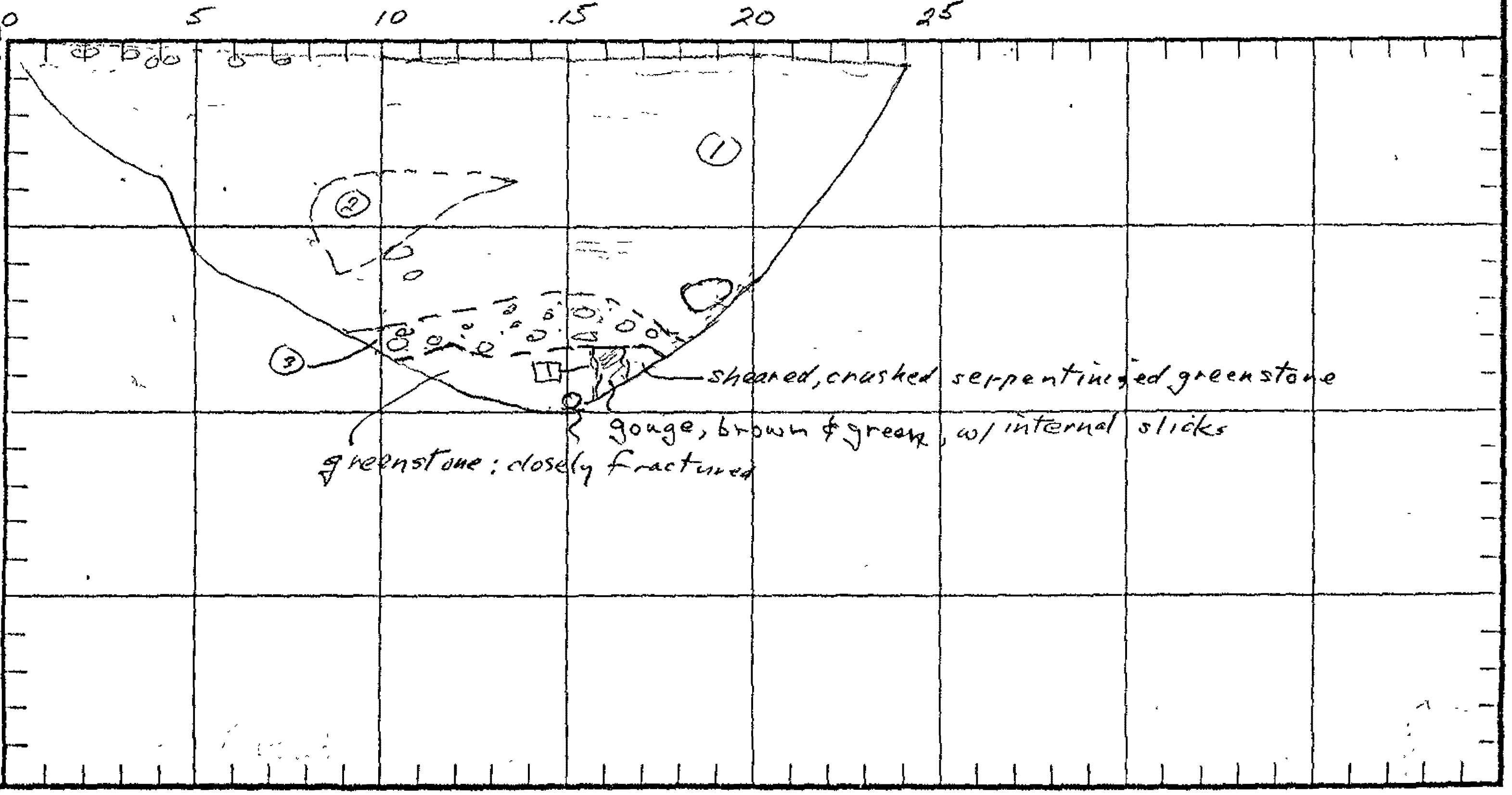
STATION →

DEPTH (EL.)


0
5
10
15
20
25
①
②
③
I
sheared, crushed serpentinized greenstone
gouge, brown & green, w/ internal slicks
greenstone: closely fractured

8/11/83
DATE

ES
LOGGED BY

0 5
SCALE, FT.

S 76° E
BEARING

EXPLORATION TEST PIT LOGS

154W

SHEET 1 OF 1	LOCATION See Figure III-2		
RIG JD-450 C	PIT WIDTH 24"	DATE 7/13/83	LOGGED BY ES

TEST PIT NO.	DEPTH INTERVAL	SOIL TYPE	WATER DEPTH	MATERIAL DESCRIPTION EXCAVATION CHARACTERISTICS	SAMPLE NUMBER	SAMPLE DEPTH
TP-1	0'-1.0	SC		FILL GRAVELLY CLAYEY SAND: brown; slightly damp; 20%-30% fines, mod. plastic; 10%-20% gravel; some cobbles, roots.		
	1.0 -6.0	CL-CH		COLLUVIUM CLAY: V. dark brown; moist; mod.-highly plastic; internal slicks; suspect highly expansive; contains 0%-10% coarse sand, angular fine gravel; excavates in chunks.	B-1	1.0-6.0
	6.0-8.5	CL-CH		TERRACE DEPOSIT SANDY CLAY: dark brown; moist; mod.-highly plastic; 5%-15% sand, fine-med.; some fine gravel; possibly Older Colluvium.	B-2	6.0-8.5
	8.5-12.5	SC		GRAVELLY CLAYEY SAND: brown; moist; 5%-20% gravel, fine, some coarse, some cobbles; 30%-40% fines, mod. plastic; 40%-65% sand, fine; possibly Older Colluvium. 11.5 dark brown w/ internal slicks, slicked cobbles of serpentine 12.0 greenish brown; much serpentine detritus;	B-3 B-4	8.5-11.5 11.5-12.5

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Wahler Associates	ANDERSON DAM SPILLWAY ENLARGEMENT	DESCRIPTIVE TEST PIT LOG		
	PALO ALTO • NEWPORT BEACH • DENVER	PROJECT NO. SCV-124A	DATE	FIGURE NO.

6/83

154W

SHEET 1 OF 1

LOCATION See Figure III-2

RIG JD-450 C

PIT WIDTH 24"

DATE 7/13/83

LOGGED BY E8

TEST PIT NO.	DEPTH INTERVAL	SOIL TYPE	WATER DEPTH	MATERIAL DESCRIPTION EXCAVATION CHARACTERISTICS	SAMPLE	
					NUMBER	DEPTH
TP-2	0.0-3.0	CL-CH		COLLUVIUM SANDY CLAY: v. dark brown-black; damp-moist; 5%-10% sand, v. fine-fine; highly plastic; excavates in chunks; Topsoil To 1.0'.	B-1	1.0-2.0
	3.0-4.0	SC-CL		TERRACE DEPOSIT GRAVELLY SANDY CLAY: greenish brown moist; 30%-40% sand, fine; 0%-10% gravel, fine; 50%-60% fines, mod. plastic; possibly an older colluvium.	B-2	3.0-4.5
	4.0-6.0	SC		FRANCISCAN FORMATION GRAVELLY CLAYEY SAND: greenish brown; moist; severely-mod. weathered graywacke; soil-like To rock-like w/ depth.	B-3	4.5-6.0

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Wahler Associates

ANDERSON DAM
SPILLWAY ENLARGEMENT

PALO ALTO • NEWPORT BEACH • DENVER

DESCRIPTIVE TEST PIT LOG

PROJECT NO.	DATE	FIGURE NO.
SCV-124A		

6/83

154W

SHEET 1 OF 1	LOCATION See Figure III - 2		
RIG JD-450 C	PIT WIDTH 24"	DATE 7/13/83	LOGGED BY EP.

TEST PIT NO.	DEPTH INTERVAL	SOIL TYPE	WATER DEPTH	MATERIAL DESCRIPTION EXCAVATION CHARACTERISTICS	SAMPLE NUMBER	SAMPLE DEPTH
TP-3	0.0-1.0	CL		FILL GRAVELLY SANDY CLAY: reddish brown; 25%-35% sand, 10%-20% gravel; mod. plastic fines; damp.		
	1.0-5.5	CL-CH		COLLUVIUM CLAY: v. dark brown; moist; internal slicks; highly plastic; suspect highly expansive; 0%-10% gravel, locally; excavates in chunks.	B-1	1.5-5.5
	5.5-10.0	CL-CH		TERRACE DEPOSIT SANDY CLAY: dark brown; moist; mod.-highly plastic; 5%-20% sand, v. fine-fine, w/some med.-cse; sand increase w/depth; 0%-5% gravel, fine; possibly an older colluvium. 9.0-10.0 Cobble, boulders w/ clay.	B-2	5.5-9.0
	10.0-12.5	SC		GRAVELLY CLAYEY SAND: brown; moist; 35%-40% fines, slightly-mod. plastic; 5%-10% gravel, fine w/ some coarse, subang.; rare cobbles; 40%-60% sand, fine-coarse. 12.0-12.5 Cobbles, boulders w/ clayey sand, serpentine detritus.	B-3	10.0-12.5

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Wahler Associates	ANDERSON DAM SPILLWAY ENLARGEMENT	DESCRIPTIVE TEST PIT LOG		
		PROJECT NO.	DATE	FIGURE NO.
	PALO ALTO • NEWPORT BEACH • DENVER	SCV-124A		

6/83

154W

SHEET 1 OF 1	LOCATION See Figure III-2		
RIG JD-450 C	PIT WIDTH 24"	DATE 7/13/83	LOGGED BY ES

TEST PIT NO.	DEPTH INTERVAL	SOIL TYPE	WATER DEPTH	MATERIAL DESCRIPTION EXCAVATION CHARACTERISTICS	SAMPLE NUMBER	SAMPLE DEPTH
TP-4	0.0-1.5	SC		COLLUVIUM GRAVELLY CLAY SAND		
	1.5-3.5	CL-CH		COLLUVIUM SANDY CLAY: v. dark brown; moist; highly plastic; internal slicks; suspect highly expansive; 10%-25% sand, fine-cse; excavates in chunks.	B-1	1.5-3.5
	3.5-5.5	SC		SERPENTINE BOULDER / GRAVELLY CLAYEY SAND w/COBBLES; partially sheared, mod.-severelly weathered serp.; soil-like to rock like. excavated w/difficulty by JD-450 C.	B-2	3.5-5.5

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ANDERSON DAM
SPILLWAY ENLARGEMENT

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DESCRIPTIVE TEST PIT LOG

PROJECT NO.	DATE	FIGURE NO.
SCV-174A		

6/83

154W

SHEET 1 OF 1	LOCATION See Figure III-2		
RIG JD-450 C	PIT WIDTH 24"	DATE 7/13/83	LOGGED BY cf -

TEST PIT NO.	DEPTH INTERVAL	SOIL TYPE	WATER DEPTH	MATERIAL DESCRIPTION EXCAVATION CHARACTERISTICS	SAMPLE NUMBER	SAMPLE DEPTH
TP-6	0.0-5.0	CL-CH		COLLUVIUM GRAVELLY SANDY CLAY: reddish brown; damp-moist; 5%-10% gravel, fine; some cobbles, boulders; 10%-35% sand (varies in lenses) fine to v. coarse; mod.-highly plastic fines; increase in sand w/ depth. 0.0 - 3.0 Internal slicks common.	B-1	1.0-3.5
	5.0 - 10.0	CL-CH		TERRACE DEPOSIT SANDY CLAY: brown - red brown; moist; 10%-20% sand, v. fine - fine; some cobbles; mod.-highly plastic; some horizons w/ internal slicks & gravelly; possibly an older colluvium	B-2	5.0-9.0
	10.0-12.0	SC		GRAVELLY CLAYEY SAND: brown-red brown; moist; 10%-30% gravel, fine; 25%-35% fines, mod. plastic; 45%-65% sand, fine-med., w/ some v. cse; some cobbles; gravel is sub ang - sub rnd, surfaces appear slicked; possibly an older colluvium.	B-3	10.0-11.0

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Wahler Associates	ANDERSON DAM SPILLWAY ENLARGEMENT	DESCRIPTIVE TEST PIT LOG	
		PROJECT NO. SCV-124 A	DATE	FIGURE NO.
	PALO ALTO • NEWPORT BEACH • DENVER		

6/83

154W

SHEET 1 OF 1	LOCATION See Figure III-2		
RIG JD-450 C	PIT WIDTH 24"	DATE 7/13/83	LOGGED BY ES

TEST PIT NO.	DEPTH INTERVAL	SOIL TYPE	WATER DEPTH	MATERIAL DESCRIPTION EXCAVATION CHARACTERISTICS	SAMPLE NUMBER	SAMPLE DEPTH
				COLLUVIUM		
TP-6	0.0-3.5	CL-CH		SANDY CLAY: v. dark brown; damp-moist; 10%-20% sand, fine-med; some gravel; highly plastic; suspect expansive; 0.0-0.5 numerous roots. 2.5-3.5 Abundant serpentine cobbles, boulders	B-1	1.0-2.5
				TERRACE DEPOSIT		
	3.5-7.5	CL-CH		GRAVELLY-SANDY CLAY: brown; moist; 15%-30% sand, v. fine-med; 5%-10% gravel, fine; some coarse gravel, some cobbles; internal slicks; mod.-highly plastic; possibly an older colluvium; contains mostly serp. detritus.	B-2	3.5-6.5
	7.5-11.0	SC		GRAVELLY CLAYEY SAND: brown; moist; 10%-15% gravel, fine, sub ang.; 30%-40% fines, slightly-mod. plastic; 45%-60% sand, fine-cse; horizons have internal slicks.	B-3	8.0-10.

THIS LOG INDICATES CONDITIONS IN THIS PIT OR TRENCH ONLY ON THE DATE INDICATED AND MAY NOT REPRESENT CONDITIONS AT OTHER LOCATIONS AND ON OTHER DATES. ANY WATER LEVELS SHOWN ARE SUBJECT TO VARIATION.

STRATIFICATION LINES OR DEPTH INTERVALS REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN MATERIAL TYPES AND THE TRANSITIONS MAY BE GRADUAL.

SOIL CLASSIFICATIONS SHOWN ON LOG ARE FIELD CLASSIFICATIONS BASED ON THE UNIFIED SOILS CLASSIFICATION SYSTEM.

6/83

Wahler Associates
PALO ALTO • NEWPORT BEACH • DENVER

ANDERSON DAM
SPILLWAY ENLARGEMENT

DESCRIPTIVE TEST PIT LOG

PROJECT NO.	DATE	FIGURE NO.
SCV-124 A		

154W

SHEET 1 OF 1	LOCATION See Figure III-2		
RIG JD-450 C	PIT WIDTH 24"	DATE 1/13/83	LOGGED BY ES

TEST PIT NO.	DEPTH INTERVAL	SOIL TYPE	WATER DEPTH	MATERIAL DESCRIPTION EXCAVATION CHARACTERISTICS	SAMPLE NUMBER	SAMPLE DEPTH
TP-7	0.0-3.0	SC		FILL GRAVELLY CLAYEY SAND W/COBBLES: brown; damp; 10%-30% gravel, fine-cse; 30%-40% fines, mod. plastic.		
	3.0-5.5	CL-CH		COLLUVIUM SANDY CLAY: v. dark brown; moist; highly plastic; internal slicks common; 5%-15% sand, fine-cse; some gravel angular, suspect expansive; excavates in chunks.		
	5.5-7.5	CL-CH		SANDY CLAY: dark brown; moist; mod.-highly plastic; 15%-30% sand, fine-cse; some gravel, fine, sub ang.;		
	7.5-10.5	SC		TERRACE DEPOSIT GRAVELLY CLAYEY SAND: brown; moist; 5%-10% gravel, ang.-sub. ang.; 25%-35% fines, slightly-mod. plastic; 55%-70% sand, fine-med.	B-1	7.5-9.5

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Wahler Associates	ANDERSON DAM SPILLWAY ENLARGEMENT	DESCRIPTIVE TEST PIT LOG		
		PROJECT NO.	DATE	FIGURE NO.
PALO ALTO • NEWPORT BEACH • DENVER		SCV-124 A		

6/83

154W

SHEET 1 OF 1	LOCATION See Figure III-2		
RIG JD-450 C	PIT WIDTH 24"	DATE 7/14/83	LOGGED BY CS.

TEST PIT NO.	DEPTH INTERVAL	SOIL TYPE	WATER DEPTH	MATERIAL DESCRIPTION EXCAVATION CHARACTERISTICS	SAMPLE NUMBER	SAMPLE DEPTH
TP-8	0.0-2.5	CL-CH		COLLUVIUM SANDY CLAY; V. dark brown to gray; damp - slightly moist; highly plastic; 10%-20% sand; includes 0.5'-1.0' w/roots, humus.		
	2.5-4.5			FRANCISCAN FM. SANDSTONE: light brown, gray brown; damp; severely - moderately weathered; rock-like w/ approx. 0.5' soil-like aureole; excavates w/ difficulty	B-1	3.0-4.5
TP-9	0.0-3.0	CL-CH		COLLUVIUM SANDY CLAY: V. dark brown; damp - moist; 10%-15% sand, fine-cse; some gravel, ang.-sub. ang.; highly plastic; internal slicks common; excavates in chunks; suspect expansive;		
	3.0-7.5	CL-CH		SANDY CLAY: med. brown; moist; 15%-30% sand, fine-med.; mod. - highly plastic; some internal slicks.	B-1	3.0-6.0
	7.5-11.5	CL-CH		TERRACE DEPOSIT SANDY CLAY; gray brown; moist; 10%-30% sand, fine; 2%-5% gravel, fine; subrnd-sub ang.; highly plastic; some internal slicks; probably an older colluvium. 11.0'-11.5 Some cobbles, boulders of serpentine; caliche streaks.	B-2	7.5-11.0

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Wahler Associates

PALO ALTO ● NEWPORT BEACH ● DENVER

ANDERSON DAM
SPILLWAY ENLARGEMENT

DESCRIPTIVE TEST PIT LOG

PROJECT NO.	DATE	FIGURE NO.
SCV-124 A		

6/83

154W

SHEET / OF /	LOCATION See Figure III-2		
RIG JD-450C	PIT WIDTH 24"	DATE 7/14/83	LOGGED BY EG

TEST PIT NO.	DEPTH INTERVAL	SOIL TYPE	WATER DEPTH	MATERIAL DESCRIPTION EXCAVATION CHARACTERISTICS	SAMPLE NUMBER	SAMPLE DEPTH
TP-10	0.0-2.5	CL-CH		COLLUVIUM SANDY CLAY: v. dark brown; damp; 5%-15% sand, fine-cso; some gravel; highly plastic; some cobbles.		
	2.5-10.0	SC, CL		TERRACE DEPOSIT GRAVELLY CLAYEY SAND, SANDY CLAY: gray brown; lenses of varying composition; 10%-15% gravel, fine, w/ 15%-30% fines, slightly plastic, and 55%-75% sand; 10%-15% sand, fine, w/ mod. plastic fines; moist; some caliche; some gravelly clayey sand horizons appear weakly cemented, have internal slicks. Measured attitude in Trench N 80°W, 45° NE on slicks w/ down dip plunge of striae in older colluvium.	B-1 B-2	3.0-5.5 7.5-9.0

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SOIL CLASSIFICATIONS SHOWN ON LOG ARE FIELD CLASSIFICATIONS BASED ON THE UNIFIED SOIL CLASSIFICATION SYSTEM.

Wahler Associates	ANDERSON DAM SPILLWAY ENLARGEMENT	DESCRIPTIVE TEST PIT LOG		
		PROJECT NO.	DATE	FIGURE NO.
	PALO ALTO • NEWPORT BEACH • DENVER	SCV-124A		

8/83

154W

SHEET 1 OF 1	LOCATION See Figure III-2		
RIG VD-450 C	PIT WIDTH 24"	DATE 4/14/83	LOGGED BY ES

TEST PIT NO.	DEPTH INTERVAL	SOIL TYPE	WATER DEPTH	MATERIAL DESCRIPTION EXCAVATION CHARACTERISTICS	SAMPLE NUMBER	SAMPLE DEPTH
TP-11	0.0-2.0	CL-CH		COLLUVIUM SANDY CLAY; v. dark brown; damp; highly plastic; 10%-15% sand, fine; some gravel; suspect expansive.	B-1	1.0-2.0
	2.0-4.0	-		FRANCISCAN FM. GRAYWACKE: light greenish brown-gray; severely-mod. weathered; has soil-like weathering aureole 2'-3'; below 3' rock-like, closely-mod. fractured.	B-2	2.0-3.5
TP-12	0.0-11.5'	SC		FILL GRAVELLY CLAYEY SAND W/COBBLES: gray, red brown; damp-moist, materials vary; 10%-30% gravel, fine-cse; 15%-25% fines, slightly plastic; 45%-75% sand, fine-med.; cobbles, boulders.	B-1	4.5-6.0
	11.5-12.0	CL		COLLUVIUM - TOPSOIL SANDY CLAY: dark brown; moist; some organics; slightly plastic.		
	12.0-12.5	GC		SERPENTINE: severely-mod. weathered; soil-like, clayey gravel		

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Wahler Associates PALO ALTO • NEWPORT BEACH • DENVER	ANDERSON DAM SPILLWAY ENLARGEMENT	DESCRIPTIVE TEST PIT LOG		
		PROJECT NO.	DATE	FIGURE NO.
		SCV-124 A		

8/83

154W

SHEET 1 OF 1	LOCATION See Figure III-2		
RIG JD-450 C	PIT WIDTH 24"	DATE 7/14/83	LOGGED BY E8

TEST PIT NO.	DEPTH INTERVAL	SOIL TYPE	WATER DEPTH	MATERIAL DESCRIPTION EXCAVATION CHARACTERISTICS	SAMPLE NUMBER	SAMPLE DEPTH
TP-13	0.0-6.0	SC		FILL GRAVELLY CLAY SAND: gray, yellow brown; damp; 15%-20% fines, slightly plastic; 10%-20% gravel; largely derived from serpentine,	B-1	1.0'6.0
	6.0-7.5	CL-CH		COLLUVIUM SANDY CLAY: v. dark brown; moist; highly plastic 10%-15% sand, fine-cse; some old roots.		
	7.5-9.0			FRANCISCAN FM. GRAYWACKE: moderately-slightly weathered; mod. hard; strong: closely fractured; rock-like but yields sandy gravel (GP-GM); excavates w/difficulty	B-2	7.5-9.0

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Wahler Associates

ANDERSON DAM
SPILLWAY ENLARGEMENT

PALO ALTO • NEWPORT BEACH • DENVER

DESCRIPTIVE TEST PIT LOG

PROJECT NO.	DATE	FIGURE NO.
SCV-124A		

8/83

154W

SHEET 1 OF 1	LOCATION See Figure III-2		
RIG JD-450 C	PIT WIDTH 24"	DATE 7/15/83	LOGGED BY ES

TEST PIT NO.	DEPTH INTERVAL	SOIL TYPE	WATER DEPTH	MATERIAL DESCRIPTION EXCAVATION CHARACTERISTICS	SAMPLE	
					NUMBER	DEPTH
TP-14	0.0-6.0	SM		FILL GRAVELLY SILTY SAND w/COBBLES: gray; damp; 10%-30% gravel, fine-cse; 20%-30% fines, non-plastic-slightly plastic; derived largely from serpentine	B-1	2.0-5.5
	6.0-9.0	CL-CH		COLLUVIUM SANDY CLAY: brown-red brown; moist; 10%-15% sand, fine-med.; mod.-highly plastic; some gravel, fine, angular.	B-2	6.0-9.0
	9.0-12.5	SC		TERRACE DEPOSIT GRAVELLY CLAYEY SAND: red brown damp-moist, 5%-10% gravel, ang.-sub.ang, fine-cse.; 20%-30% fines, slightly plastic; 60%-75% sand, fine-cse.; contains some lenses of sandy clay (CL-CH); an older colluvium 12.0-12.5 Cobbles, boulders of graywacke.	B-3	9.0-11.5

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Wahler Associates	ANDERSON DAM SPILLWAY ENLARGEMENT	DESCRIPTIVE TEST PIT LOG		
		PROJECT NO.	DATE	FIGURE NO.
PALO ALTO ● NEWPORT BEACH ● DENVER		SCV-124 A		

8/83

154W

SHEET / OF /	LOCATION See Figure III-2		
RIG JD-450	PIT WIDTH 24"	DATE 7/18/83	LOGGED BY ES

TEST PIT NO.	DEPTH INTERVAL	SOIL TYPE	WATER DEPTH	MATERIAL DESCRIPTION EXCAVATION CHARACTERISTICS	SAMPLE	
					NUMBER	DEPTH
TP-15	0.0-2.0	SC		FILL GRAVELLY CLAYEY SAND: Red brown and gray; damp- slightly moist. 15%-25% gravel; 15%-25% fines, slightly - mod. plastic.		
	2.0-4.0	CL		TERRACE DEPOSIT SANDY CLAY: Tan; moist; 0% - 5% gravel; 30%-40% sand, v. fine - fine; 60%-70% fines moderately plastic.	B-1	2.0-4.0
	4.0-10.0	SC	5.0	GRAVELLY CLAYEY SAND: brown; moist + wet; 5%-30% gravel, fine, varies in layers; 20%-30% fines, slightly -moderately plastic; 50%-75% sand, fine - med.. 8.0' cobbles, boulders.	B-2	4.0-8.0
	10.0-11.0	SP	10.0	GRAVELLY SAND W/COBBLES: brown; wet; 10%-30% gravel, fine - cse.; sub rnd., hard, Franciscan;		

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Wahler Associates	ANDERSON DAM SPILLWAY ENLARGEMENT	DESCRIPTIVE TEST PIT LOG		
	PALO ALTO ● NEWPORT BEACH ● DENVER	PROJECT NO. SCV-124 A	DATE	FIGURE NO.

8/83

154W

SHEET / OF /	LOCATION See Figure III-2		
RIG JD-450C	PIT WIDTH 24"	DATE 7/18/83	LOGGED BY E8

TEST PIT NO.	DEPTH INTERVAL	SOIL TYPE	WATER DEPTH	MATERIAL DESCRIPTION EXCAVATION CHARACTERISTICS	SAMPLE NUMBER	SAMPLE DEPTH
TP-16	0.0-4.0	GC		FILL SANDY CLAYEY GRAVEL: red brown; damp - moist; 40%-60% gravel; fine - cse; sub rnd - sub ang.; 10%-15% clay; mod. plastic; roots.		
	4.0-11.5	SC		TERRACE DEPOSIT GRAVELLY CLAYEY SAND: brown; moist; 5%-15% gravel, fine, subang-sub rnd.; 30%-40% fines, mod. plastic; 50%-65% sand, fine-med; has horizons w/ internal slicks; poorly indurated; 8.0-9.0 cobbles, boulders.	B-1 B-2	5.0-7.0 9.5-10.5
TP-17	0.0-5.0	GC		FILL SANDY CLAYEY GRAVEL: gray; damp; derived largely from serpentine; 40%-60% gravel, fine-cse.; 15%-20% fines, slightly plastic. 4.0-5.0 Brown, derived from terrace deposit.		
	5.0-7.5	SC		TERRACE DEPOSIT CLAYEY SAND: light brown, moist; some gravel; 25%-35% fines, mod. plastic; 65%-75% sand, fine - med.; poorly indurated; some horizons w/ 10%-20% gravel, fine.		
	7.5-11.5	SP-SC		GRAVELLY SAND: brown; moist; 20%-30% gravel, fine - cse., hard, subrnd. - subang., Franciscan; 60%-70% sand, med. - cse.; 5%-10% fines, slightly plastic; some cobbles.		

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Wahler Associates	ANDERSON DAM SPILLWAY ENLARGEMENT	DESCRIPTIVE TEST PIT LOG		
		PROJECT NO.	DATE	FIGURE NO.
	PALO ALTO • NEWPORT BEACH • DENVER	SCV-124 A		

6/83

154W

SHEET 1 OF 1
LOCATION See Figure III-2
RIG LD-450 C
PIT WIDTH 24"
DATE 7/18/83
LOGGED BY ES

TEST PIT NO.	DEPTH INTERVAL	SOIL TYPE	WATER DEPTH	MATERIAL DESCRIPTION EXCAVATION CHARACTERISTICS	SAMPLE	
					NUMBER	DEPTH
TP-18	0.0-0.5	SM		FILL GRAVELLY SILTY SAND: brown; damp.		
	0.5-8.0	GP-GM		TERRACE DEPOSIT SILTY SANDY GRAVEL W/COBBLES: brown-gray; slightly moist-moist; 60%-70% gravel, fine-cse., sub ang.-sub. rnd., hard, Franciscan; 30%-40% sand, med.-cse., 5%-10% fines, non plastic; contains a few boulders; appears to be loose.	B-1	4.0-8.0
	8.0-11.5	GC		FRANCISCAN FM. SHEARED GRAYWACKE/GOUGE: gray-dark gray; moist; dark grey-gray gouge w/ well developed slickensides (unable to determine orientation from surface); contains gravel to cobble size pieces of mod. hard graywacke w/ well developed bedding.	B-2	8.0-11.5
TP-19	0.0-5.0	GC		FILL SANDY CLAYEY GRAVEL: Grey, brown; damp-moist; 50%-60% gravel, fine-cse., ang.-subrnd, mixed Franciscan, 15%-25% fines, mod. plastic; some cobbles		
	5.0-11.5	CL&CH		GRAVELLY SANDY CLAY: dark gray; moist; 10%-25% gravel, fine-cse., mixed lithology, ang.-subrnd.; 15%-30% sand, fine-cse.; 60%-75% fines, mod.-highly plastic; contains cobbles & boulders of sandstone, silica carbonate; no slicks.		

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Wahler Associates
PALO ALTO • NEWPORT BEACH • DENVER

ANDERSON DAM
SPILLWAY ENLARGEMENT

DESCRIPTIVE TEST PIT LOG

PROJECT NO.	DATE	FIGURE NO.
SCV-124A		

6/83

154W

SHEET / OF /	LOCATION See Figure III-2		
RIG JD-450 C	PIT WIDTH 24"	DATE 8/10/83	LOGGED BY PCD/ES

TEST PIT NO.	DEPTH INTERVAL	SOIL TYPE	WATER DEPTH	* MATERIAL DESCRIPTION EXCAVATION CHARACTERISTICS	SAMPLE NUMBER	SAMPLE DEPTH
TP-20	0.0-2.5	SC-CL		FILL SANDY GRAVELLY CLAY: med. brown; slightly damp; mod. plastic; 15% gravel, subround;	B-1	2.5
	2.5-6.0	SC		GRAVELLY CLAYEY SAND: greenish gray; moist; mod. plastic; 15% gravel, subround.	B-2	6.0
TP-21	0.0-2.0	CL-CH		COLLUVIUM CLAY: dark brown; mod.-highly plastic.		
	2.0-4.0	SC		TERRACE DEPOSIT CLAYEY SAND: buff; mod. indurated; slightly damp; sandstone.	B-3	4.0

* Description from Field Density Test record.

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Wahler Associates

ANDERSON DAM
SPILLWAY ENLARGEMENT

PALO ALTO ● NEWPORT BEACH ● DENVER

DESCRIPTIVE TEST PIT LOG

PROJECT NO.	DATE	FIGURE NO.
SCV-124 A		

8/83

154W

SHEET 1 OF 1	LOCATION See Figure III-2		
RIG JD-450 C	PIT WIDTH 24"	DATE 8/10/83	LOGGED BY PCD/ES.

TEST PIT NO.	DEPTH INTERVAL	SOIL TYPE	WATER DEPTH	* MATERIAL DESCRIPTION EXCAVATION CHARACTERISTICS	SAMPLE	
					NUMBER	DEPTH
TP-22	0.0-2.5	CH		COLLUVIUM CLAY: dark grey - black; highly plastic.		
	2.5-6.5	CL		TERRACE DEPOSIT SANDY CLAY: med. - dark brown, gray brown; mod. - highly plastic; 5% gravel, rounded.	B-4 B-5	4.0 6.5
TP-23	0.0-1.5	CL		FILL CLAY:		
	1.5-4.0	CH		COLLUVIUM CLAY: black; highly plastic; abundant dessication cracks and internal slicks	B-6	4.0
	4.0-6.0	CL-CH		CLAY: black; slightly damp; mod. - highly plastic.	B-7	6.0
TP-24	0.0-6.0	CL-GC	6.0	SLOPEWASH CLAYEY GRAVEL = GRAVELLY CLAY: dark reddish brown.	B-8	2.0

* Description from Field Density test record.

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Wahler Associates	ANDERSON DAM SPILLWAY ENLARGEMENT	DESCRIPTIVE TEST PIT LOG		
		PROJECT NO.	DATE	FIGURE NO.
	PALO ALTO ● NEWPORT BEACH ● DENVER	SCV-124 A		

6/83

DRILL HOLE LOGS
PROPOSED SPILLWAY ENLARGEMENT
AND DAM CREST

BORING LOCATION Levee crest, left side spillway sta 3+10; 105' Left			GROUND EL. 640.5'
DEPTH/ELEV. WATER	DRILL CONTRACTOR Pitcher Drilling Co		TOTAL DEPTH 45.0
DRILL RIG Failing 750	BORING DIA. 5"	DATE DRILLED 18-19 July 83	LOGGED BY -PCD

SOIL CLASS.	DESCRIPTION	DEPTH	SAMPLE NO.	PR / RQD	REC.	MODE	REMARKS
SC	EMBANKMENT FILL 0.0–24.0 GRAVELLY CLAYEY SAND; reddish brown; dry; moderate to low plasticity; up to 40% sand, fine to coarse; subangular; 15-20% gravels, up to 3"; angular and rounded	0 2		–	–	AD	0.0-3.0 Drilled w/ 6" flight auger. Set casing and established circulation w/ bentonitic mud (very light)
		4	S-1	–	1.7/2.5	PB	3.0-5.5 Pitcher barrel 4.5" OD - 3" shelby tube ID, Minimal water loss during drilling; intermittent rough drilling (3" cobble scrap stuck in end of shelby)
		6				RD	5.5-7.5 Tricone rockbit to clear hole (4 7/8" dia)
	Gravelly sandy clay/ Sandy, clayey gravel	8	S-2	–	100%	PB	7.5-10.0 Pitcher barrel Intermittent rough and rocky drilling; mod. damage to shelby tip; no water loss
		10 12				RD	10.0-12.5 Trizone rockbit
	gravelly silty sand; reddish brown.	14	S-3	–	2.3/2.5	PB	12.5-15.0 Pitcher Barrel Relatively smooth drilling. slight damage to shelby tip. Good sample no water loss
		16				RD	15.0-17.5 Tricone rockbit
	gravelly silty sand.	18 20	S-4	–	1.9/2.5	PB	17.5-20.0 Pitcher barrel; smooth cut. full fluid return

Wahler Associates

ANDERSON DAM SPILLWAY ENLARGEMENT

EXPLORATION BORING LOG

PROJECT NO. SCV124A

SHEET NO. 1 OF 3

BORING NO. AD-1

BORING LOCATION			GROUND EL.
DEPTH/ELEV. WATER		DRILL CONTRACTOR	TOTAL DEPTH
DRILL RIG	BORING DIA.	DATE DRILLED	LOGGED BY -

SOIL CLASS.	DESCRIPTION	DEPTH	SAMPLE NO.	PR / RQD	REC.	MODE	REMARKS
SM-GM	EMBANKMENT FILL 0.0-24.0 SANDY CLAY w/ GRAVELS (continued)	20				RD	20.0-20.5 Drilled w/ 4⅞" tricone rock bit
		22	S-5	—	1.6/2.5	PB	20.5-23.0 Pitcher barrel; softer drilling below 21.0; continued full water return; drilling harder below 22.0
	BEDROCK	24	S-6	-	1.8/2.0	PB	23.0 - 25.0 Pitcher barrel
	24.0-45.0 SERPENTINE gray green; severely weathered w/ abundant red clay, mod. plastic; waxy fibrous nature; soft; weak. in S-7, serpentine sheared and fractured; weathered to red brn gravelly clayey sand.	26	S-7	—	2.0/2.5	PB	25.0-27.5 Pitcher barrel; soft cut
	Serpentine; gry green; extensive sheared; soft; waxy	28	S-8	-	1.8/2.5	PB	27.5-30.0 Pitcher barrel; continued soft cut
	Serpentine; gry green sheared matrix, soft; weak w/ brownish gry metasandstone fragments, angular, broken; up to 2" dia	30 32	S-9	-	1.8/2.5	PB	30.0-32.5 Pitcher barrel; continued soft cut; full fluid return; Moderate fluid loss while washing hole,
	Serpentine w/ severely weathered greenstone (?)	34	S-10	—	2.2/2.5	PB	32.5-35.0 Pitcher barrel; soft drilling; rapid cut; continued mod to slight water loss
		36	S-11	-	1.8/2.5	PB	35.0-37.5 Pitcher Barrel; smooth cut, soft; continued low to mod fluid loss (water only)
	Med dense to dense sheared green gry serpentine w/ brownish oxidation bands	38 40	S-12	-	2.0/2.5	PB	37.5-40.0 Pitcher barrel Filled hole to top w/ water @ 15:30 18 Jul 83 19 Jul 83

Wahler Associates	ANDERSON DAM SPILLWAY ENLARGEMENT	EXPLORATION BORING LOG	BORING NO.
		PROJECT NO. SCV124-A / SHEET NO. 2 OF 3	AD-1

BORING LOCATION		GROUND EL.
DEPTH/ELEV. WATER	DRILL CONTRACTOR	TOTAL DEPTH
DRILL RIG	BORING DIA. DATE DRILLED	LOGGED BY -

SOIL CLASS.	DESCRIPTION	DEPTH	SAMPLE NO.	PR / RQD	REC.	MODE	REMARKS
	BEDROCK (CONTINUED) 24.0 - 45.0 SERPENTINITE Sheared, soft, oxidized	40				C	19 July 83 Water measured @ 23.0' 0815 AM. Cave to ~36' 40.0 - 45.0 Cored w/ 5' long NX core barrel V. slight water loss throughout mod. loss below 43.0 - Appears to be sl. fr. and some soft sheared serpentine Made three unsuccessful attempts to seat packer
		42	X-1	0%	2.0/5.0		
		44					
	± TOTAL DEPTH 45.0'	46					Unsuccessful due to caving and inability to seat packer in fractured serpentine. Installed piezometer (see piezometer data sheet for AD-1)
		48					
		50					
		52					
		54					
		56					
		58					
		60					

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Wahler Associates	ANDERSON DAM SPILLWAY ENLARGEMENT	EXPLORATION BORING LOG		BORING NO.
		PROJECT NO. SCV124A	SHEET NO. 3 OF 3	AD-1

BORING LOCATION	Near Spillway Crest; Sta 4+11, 116' left.	GROUND EL.	630.1'
DEPTH/ELEV. WATER	DRILL CONTRACTOR Pitcher Drilling Co	TOTAL DEPTH	40.0
DRILL RIG Failing 750	BORING DIA. 5" DATE DRILLED 19-20 Jul 83	LOGGED BY	PCD

SOIL CLASS.	DESCRIPTION	DEPTH	SAMPLE NO.	PR / RQD	REC.	MODE	REMARKS
CL	FILL 0.0-4.0 SANDY CLAY w/ GRAVELS: reddish brown; dry; low to mod. plasticity; loose to med. dense; occasional well rounded pebbles to 1½" dia; serpentine blocks; roots and rootlets	0 2				AD	0.0-3.0 Drilled w/ 6" auger Set casing and established circulation w/ water only
GP-GC	4.0-13.0 SANDY GRAVEL; clayey; mostly serpentine fragments; Bluish gray; severely weathered and sheared; soft; weak; roots near top. containing occasional less weathered blocks of brown gray graywacke ss; rounded to subrounded pebbles up to 1" dia	4	S-1	-	1.8/2.5	PB	3.0-5.5 Pitcher barrel 4.5" OD w/ 3" Shelby tube; full fluid return
		6				RD	5.5-7.5 Drilled w/ 4⅞ tricone rock bit and water rough drilling; slight water loss
		8	S2*	-	1.5/2.5	PB	7.5-10.0 Pitcher barrel. intermittent hard and soft drilling - rough in places *disturbed sample retained in plastic bag
		10 12 14				RD	10.0-15.0 Tricone rockbit Intermittent hard and soft drilling; cont mud slight water loss
CL	13.0-19.0 SANDY CLAY w/ GRAVELS: Gray brown; mod plasticity; 25-30% coarse sand to fn gravel materials; sub angular to sub rounded; med. dense.	16	S-3	-	1.1/2.0	PB	15.0-17.0 Pitcher barrel generally smooth cut; slight water loss Filled hole to top w/ water WL @ 10' in AM. Hole caved to 11.0' 19 Jul 83
						RD	20 Jul 83
SC-GC	19.0-20.6' GRAVELLY CLAYEY SAND. gray brn; 25-30% gravel; 30-35% sand. mod. plastic fines. dk brn soil w/ serpentine gravel size fragments; angular fresh broken surfaces.	18 20	S-4	-	1.5/2.5	PB	17.0-17.5 Tricone rockbit with heavy mud 17.5-20.0 Pitcher barrel cut w/ heavy mud. soft below 19.6'

Wahler Associates

ANDERSON DAM SPILLWAY ENLARGEMENT

EXPLORATION BORING LOG			BORING NO.
PROJECT NO.	SCV 124	SHEET NO. 1 OF 2	AP-2

BORING LOCATION		GROUND EL.
DEPTH/ELEV. WATER	DRILL CONTRACTOR	TOTAL DEPTH
DRILL RIG	BORING DIA. / DATE DRILLED	LOGGED BY -

SOIL CLASS.	DESCRIPTION	DEPTH	SAMPLE NO.	PR / RQD	REC.	MODE	REMARKS
	FILL (CONTINUED)	20					
SC-GC	20.0-25.0' CLAYEY SAND - CLAYEY GRAVEL: Dk gray brown; low plasticity; 30-40% sand, med to coarse; 25-35% gravels up to 2" dia, angular; loose; weak; poorly consolidated	22	S-5*		0.8/2.5	PB	20.0-22.5 Pitcher barrel *sample retained in plastic bag due to disturbance of tube
	Distinct soil like material (dk. brown clay in weathered serpentine rock; jumbled, assemblage	24	R-1	17/33/50	1.0/1.5	DR	22.5-24.0 drive ring sampler 2.5" ID 3.0" OD (sampler)
	BEDROCK 25.0-40.0 SERPENTINE: Grayish green mottled brn; severely weathered, sheared, weak rare root near upper contact;	26				RD	24.0-27.5 Tricone rockbit w/ heavy mud Consistently harder drilling below 26.0
		28	R-2	30/33/40	1.2/1.5	DR	27.5-29.0' drive 2.5" ring sampler
		30				RD	29.0-32.5 tricone rockbit Consistent drilling w/ occasional hard areas
	32.0-35.0 oxidized serpentine zone; brown & blue gray blocks of less altered serpentine; weak	32	R-3	57/60	1.3/1.5	DR	32.5-33.5 drive 2.5" ring sampler Sampler hanging up on well
		34				RD	33.5-35.0 rockbit. Some fluid loss this interval
	35.0-40.0 severely weathered SERPENTINE; brown and blue gray; crumbly; med. dense; weak to mod. strong; partially to wholly oxidized some sections	36	S-6	-	1.4/2.5	PB	35.0-37.5 Pitcher barrel; consistant steady cut - slow - tube badly damaged
		38				RD	37.5-38.5 rockbit
		40	R-4	35/40/40	1.5/1.5	DR	38.5-40.0 ring sampler Installed piezo after heavy flushing
	TOTAL DEPTH 40.0'						

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Wahler Associates	ANDERSON DAM SPILLWAY ENLARGEMENT	EXPLORATION BORING LOG		BORING NO.
		PROJECT NO. SCV124A24	SHEET NO. 2 OF 2	AD-2

BORING LOCATION left side spillway; Sta 6+04; 78' left
GROUND EL. 591.8'
DEPTH/ELEV. WATER
DRILL CONTRACTOR Pitcher Drilling
TOTAL DEPTH 30.0
DRILL RIG Failing 750
BORING DIA. 5"
DATE DRILLED 20-21 Jul, 83
LOGGED BY PCD

SOIL CLASS.	DESCRIPTION	DEPTH	SAMPLE NO.	PR / RQD	REC.	MODE	REMARKS
CL	COLLUVIUM 0.0-7.0 SILTY CLAY/ SANDY CLAY: Dark brown; firm to stiff; 15 to 20% sand, fine to med; occasional subangular gravels to 1.5"; mod to high plasticity (rare expansion cracks @ surface to 1/2")	0 2				AD	0.0-3.5 Drilled w/ 6" continuous flight auger; firm drilling
		4	R-1	11/12/15	1.2/1.5	DR	3.5-5.0 drive 2.5" ring sampler 20 Jul, 83
CL	TERRACE DEPOSIT 7.0-30.0' GRAVELLY SANDY CLAY med to dk brown, firm to stiff; mod plasticity; gravels up to 2" dia, subrounded, serpentine; slightly damp.	6 8				RD	21 Jul, 83 Set up with water. 5.0-8.5 drilled w/ 4 7/8" tricone and water Mod. increase in gravels (drilling rougher) below 7'
			R-2	8/15/23	1.5/1.5	DR	8.5-10.0 drive ring Sampler
		10 12				RD	10.0-12.5 tricone rockbit. Full fluid return; smooth, steady drilling
		14	S-1	—	2.5/2.5	PB	12.5-15.0 Pitcher barrel; 4.5" OD, 3.0" shelby tube; smooth cut
		16 18				RD	15.0-18.5 tricone rock bit; no water loss drilling w/ water only
		20	R-3	15/18/28	1.5/1.5	DR	18.5-20.0 drive ring sampler

Wahler Associates

ANDERSON DAM SPILLWAY ENLARGEMENT

EXPLORATION BORING LOG
PROJECT NO. SCV 124A
SHEET NO. 1 OF 2
BORING NO. AD-3

BORING LOCATION			GROUND EL.
DEPTH/ELEV. WATER	DRILL CONTRACTOR		TOTAL DEPTH
DRILL RIG	BORING DIA.	DATE DRILLED	LOGGED BY -

SOIL CLASS.	DESCRIPTION	DEPTH	SAMPLE NO.	PR / RQD	REC.	MODE	REMARKS
CL	TERRACE DEPOSIT cont...	20					
	7.0 - 30.0 GRAVELLY SANDY CLAY: slightly increasing amounts of of gravels with depth; mostly serpentine.					RD	20.0 - 22.5 Tricone rockbit; rough drilling below 21.5 feet
		22					
		24	S-2	-	1.8/2.5	PB	22.5 - 25.0 Pitcher barrel; smooth cut
		26				RD	25.0-28.5 Tricone rockbit
		28					
			R-4	45/70	0.8/1.0	DR	28.5 - 29.5 Drive ring sample
		30				RD	29.5-30.0 Tricone rockbit
	TOTAL DEPTH, 30.0						Piezometer installed (see sheet)
		32					
		34					
		36					
		38					
		40					

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Wahler Associates	ANDERSON DAM SPILLWAY ENLARGEMENT	EXPLORATION BORING LOG		BORING NO.
		PROJECT NO. SCV124A	SHEET NO. 2 OF 2	AD-3

BORING LOCATION left side spillway: Sta 8+01; 72' left		GROUND EL. 576.4
DEPTH/ELEV. WATER	DRILL CONTRACTOR Pitcher Drilling Co	TOTAL DEPTH 32.0
DRILL RIG Failing 750	BORING DIA. 3.0"	DATE DRILLED 21-22 July 83
		LOGGED BY KD

SOIL CLASS.	DESCRIPTION	DEPTH	SAMPLE NO.	PR / RQD	REC.	MODE	REMARKS
CL-CH	COLLUVIUM 0.0-7.0 SANDY CLAY w/ GRAVELS: med brown to dk brown; stiff; mod to highly plastic; 15-20% sand, fn to coarse; 5-20% gravels, subangular to subrounded up to 2" dia; slightly damp	0 2				AD	0.0-3.5 Drilled w/ 6" continuous flight auger
		4	R-1	10/18/26		DR	3.5-5.0 Drive Ring sampler
		6				RD	5.0-7.5 Drilled w/ 4 7/8" tricone rockbit and light mud
CL	TERRACE DEPOSIT 7.0-16.5 SILTY CLAY/GRAVELLY CLAY: Gry brown; firm to stiff; mod. plastic; weathered Serpentine materials; gravels up to 2" dia subrounded; damp; crumbly.	8	S-1	—	2.5/2.5	PB	7.5-10.0 Pitcher barrel; smooth cut; full fluid return, UNDAMAGED TUBE!
		10 12				RD	10.0-13.0 Rockbit. slight increase in gravels encountered w/ depth return fluid lt gray
	Caliche rich; mod. to highly plastic	14	R-2	12/27/43	1.3/1.5	DR	13.0-14.5 Drive ring sampler
		16				RD	14.5-17.5 tricone rockbit return fluid light gray full fluid return Hard drilling @ 16.0' and 16.5' through 17.5'
	BEDROCK 16.5-32.0 SANDSTONE graywacke sandstone: v. hard & strong; fresh; calcitic veinlets	18	S-2	—	0.3/1.0	PB	17.5-18.5 Pitcher barrel. Tube badly damaged; 4"-rock in end
		20					18.5-20.0 steady, v. hard slow rough drilling w/ tricone rockbit

Wahler Associates	ANDERSON DAM SPILLWAY ENLARGEMENT	EXPLORATION BORING LOG	BORING NO. AD-4
		PROJECT NO. SCV124A	SHEET NO. 1 OF 2

BORING LOCATION			GROUND EL.
DEPTH/ELEV. WATER	DRILL CONTRACTOR		TOTAL DEPTH
DRILL RIG	BORING DIA.	DATE DRILLED	LOGGED BY -

SOIL CLASS.	DESCRIPTION	DEPTH	SAMPLE NO.	PR / RQD	REC.	MODE	REMARKS
	16.5-32.0 SANDSTONE Continued 18.5-21.5 moderately fractured; hard, v. strong fine to med grained; calcitic veinlets. 21.5-23.5 close to intensely fractured angular fragments of crushed rock 2" max dia	20 22		1.1 / 3.5	100%	C	20.0-23.5 Coring w/ Nx core barrel and water 21 July 83
	23.5-26.4 close to moderately fractured, occasional mild oxidation staining along steeply dipping irregular fractures. v. hard, v. strong, fine grained, well cemented; calcitic stringers; slicks on some fracture surfaces 30° dip	24 26	X-1	1.4 / 3.6	100%	C	22 July 83 23.5-27.1 Core run v. slight water loss (almost zero)
	26.4-30.0 close to intensely fractured 30.0-32.0 low to mod. low permeability; intensely fractured, rock shows previous faulting offset and recementation; slight oxidation staining	28 30		0.6 / 3.1	83%	C	27.1-32.0 Core run Soft drilling below 30 - slight fluid loss that returned
	BOTTOM OF BORING 32.0'	32 34 36 38 40					Installed piezometer (see sheet)

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		PROJECT NO. SCV124A	SHEET NO. 2 OF 2	AD-4

BORING LOCATION Left side spillway; Sta. 10+93; 71' left.		GROUND EL. 552.5'
DEPTH/ELEV. WATER	DRILL CONTRACTOR Pitcher Drilling Co.	TOTAL DEPTH 30.0'
DRILL RIG Failing 750	BORING DIA. 5" DATE DRILLED July 25, 1983	LOGGED BY PCD

SOIL CLASS.	DESCRIPTION	DEPTH (FT)	SAMPLE NO.	PR / RQD	REC.	MODE	REMARKS
CL-SC	FILL 0.0-5.5 GRAVELLY SANDY CLAY grading to GRAVELLY CLAYEY SAND; yell. brn mottled with reddish brn and dk gray; mod. to highly plastic, sl. damp; 20-30% subangular to subrounded gravels; 30-35% sand.	0 2				AD	AD- Drilled w/ 6" flight auger; intermittent rocky drilling
		4	R-1	10/14/28	100%	DR	3.0-4.5 Drive 2.5" ring sampler.
	5.5-9.0 GRAVELLY CLAYEY SAND; gravels mostly serpentine;	6				AD	
		8				RD	6.0-8.5 Drilled with 4 7/8" tricone rock bit and water; full fluid return
SC	TERRACE DEPOSIT 9.0-16.0 GRAVELLY CLAYEY SAND; blue gray to greenish gray; 15-20% gravels mostly serpentine, rounded; in S-1, 9-9.8, red brown clayey sand - some coarse sand	10	S-1		2.5/2.5	PB	8.5-11.0 Pitcher barrel sampling, 3" shelby tube, easy drilling; full fluid return.
		12				RD	full fluid return.
	14.5', roots with blue gray oxidation halo in clay.	14	R-2	8/15/30	100%	DR	13.0-14.5 Ring sampler
	16.0-18.0 - SANDY GRAVEL; gray; medium dense; rounded.	16				RD	14.5-17.5 Rock bit; steady firm drilling slight water loss at ~15'.
	BEDROCK 18.0-21.0' SANDSTONE; gray, hard, fractured; slightly weathered strong.	18 20	S-2		1.3/2.5	PB	17.5-20.0 Rough sampling below 19'; continued slight water loss.

Wahler Associates

ANDERSON DAM SPILLWAY ENLARGEMENT

EXPLORATION BORING LOG		BORING NO.
PROJECT NO. SCV124A	SHEET NO. 1 OF 2	AD-5

BORING LOCATION		GROUND EL.
DEPTH/ELEV. WATER	DRILL CONTRACTOR	TOTAL DEPTH
DRILL RIG	BORING DIA.	DATE DRILLED
		LOGGED BY

SOIL CLASS.	DESCRIPTION	DEPTH	SAMPLE NO.	PR / RQD	REC.	MODE	REMARKS
	21.0' - 30.0 - SHALE ; dK. bluegray; weathered	20 22				RD	20,0 - 23,5 Rock bit. slight fluid loss; easy drilling; heavy blue gray fluid return
	in R-3, mod weathered, pervasively sheared; internal slickensides	24	R-3	25 40 60		DR	23.5 - 25.0 Ring sampler. Clean hole to 25' with rock bit.
	in S-3, slightly weathered dK gray; mod. strong.	26	S-1		2.1/2.5	PB	25 - 27.5 - Sampled with heavy mud. Slow smooth steady drilling.
		28	S-4		2.1/2.5	PB	Flushed hole with clean water prior to piezometer installation.
	BOTTOM OF BORING - 30.0'	30					Installed piezometer. See piezometer data sheet.
		32					
		34					
		36					
		38					
		40					

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Wahler Associates	ANDERSON DAM SPILLWAY ENLARGEMENT	EXPLORATION BORING LOG		BORING NO.
		PROJECT NO. SCV 124-A	SHEET NO. 2 OF 2	AP- 5

566 invert

BORING LOCATION	Station 7+00, 59' Lt. of ℄	GROUND EL.	585
DEPTH/ELEV. WATER	17.5' 8/9/83	DRILL CONTRACTOR	Weyer
TOTAL DEPTH	25.3		
DRILL RIG	Mobil B-40L	BORING DIA.	0.5'
DATE DRILLED	8/9/83	LOGGED BY	E.S

SOIL CLASS.	DESCRIPTION	DEPTH	SAMPLE NO.	PR / RQD	REC.	MODE	REMARKS
CL-CH	FILL 0.0 - 1.5 GRAVELLY SANDY CLAY: dark brown; slightly damp.	0				AD	Drill w/ 6" flight auger.
CL-CH	COLLUVIUM 1.5 - 8.0 SANDY CLAY: dark brown; moist; 5%-10% sand, v. fine - fine; moderately - highly plastic fines; some fine gravel.	2 4 6					
CL-CH	TERRACE DEPOSIT 8.0 - 11.0(?) SANDY CLAY: medium brown - red brown; 20%-30% sand, v. fine - fine; some gravel, fine; possibly a transition zone.	8 10	S-1		2.2 2.3	P	10.0 - 12.3 Push; refuse @ 12.3' @ 1200 psi; pulled off sample 0.1'.
CL	11.0(?) - 17.0 SANDY CLAY: med. yel. brn; 20%-30% sand, v. fine - fine; pervasively internally slickensided; damp.	12 14 16				AD	
SC	FRANCISCAN FM. 17.0 - 20.0 SANDSTONE - CLAYEY SAND: severely weathered; soil-like; v. dense; yellow brown.	18	B-1	30 29 50/4	1.0 1.4	DR	18.0 - 19.4 Standard penetration test: 140# hammer, 30" drop.
		20				AD	20.0 Encounter water.

Wahler Associates	ANDERSON DAM SPILLWAY ENLARGEMENT	EXPLORATION BORING LOG		BORING NO.
		PROJECT NO. SCV-124 A	SHEET NO. 1 OF 2	AD-6

BORING LOCATION			GROUND EL.
DEPTH/ELEV. WATER		DRILL CONTRACTOR	TOTAL DEPTH
DRILL RIG	BORING DIA.	DATE DRILLED	LOGGED BY -

SOIL CLASS.	DESCRIPTION	DEPTH	SAMPLE NO.	PR / RQD	REC.	MODE	REMARKS
	FRANCISCAN FM						
GC	20.0 - 25.3 SHALE - CLAYEY GRAVEL: dark gray - black; wet; v. dense; soil-like to rock-like; moderately to severely weathered; intensely fractured	20	B-2	50/.3	0.3	DR	20.0 - 20.3 SPT.
						AD	
		22					
		24					
			B-3	50/.3	0.3	DR	25.0 - 25.3 SPT
	TOTAL DEPTH 25.3	26					25.3 Terminate hole. Back fill w/cuttings

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Wahler Associates	EXPLORATION BORING LOG		BORING NO.
	PROJECT NO.	SHEET NO.	
	SCV-124A	2 OF 2	AD-6

BORING LOCATION Station 9+50, 58' Lt. of ℄			GROUND EL. 563
DEPTH/ELEV. WATER 18.5' 8/9/83	DRILL CONTRACTOR Weyer		TOTAL DEPTH 21.5
DRILL RIG Mobil B-40L	BORING DIA. 0.5'	DATE DRILLED 8/9/83	LOGGED BY E-S

SOIL CLASS.	DESCRIPTION	DEPTH	SAMPLE NO.	PR / RQD	REC.	MODE	REMARKS
CL-CH	COLLUVIUM 0.0-1.0 SANDY CLAY: dark brown; damp; 5%-10% sand; moderately - highly plastic.	0				AD	Drill w/ 6" flight auger.
SC	TERRACE DEPOSIT 1.0 - 13.0 GRAVELLY CLAYEY SAND: Tan - yellow brown, brown; moist; 15% - 35% fines, mod. plastic; 10% - 35% gravel fine - coarse, subang. - sub. rnd., mixed Franciscan; 50% - 60% sand, med. - cse.; lenses of finer and coarser materials w/ increase in gravel w/ depth	2 4					
			B-1		0.4	P	5.0 - 5.4 Push 3" liner; refused.
		6				AD	
GC	8.0 - 9.0 Sandy clayey gravel	8	B-2				
SC		10 12					
GC	13.0 - 19.0 SANDY CLAYEY GRAVEL: gray brown; moist; 15% fines; fine to coarse gravel, sub rnd. - sub. ang.; mixed Franciscan.	14					
	15.2 - 19.0 Cobbles: w/ clay & gravel.		B-3	50/.2	0.2	DR	15.0 - 15.2 Standard penetration test: 140# hammer, 30" drop; refuse @ 0.2'.
		16 18				AD	15.2 - 16.0 Very hard; suspect cobbles. 16.0 Refused, move rig 4.5' south. Redrill hole: hard, drilling 13.0 - 19.0.
	FRANCISCAN FM. 19.0 - 21.5 CRUSHED, ALTERED SANDSTONE @ see page 2.	20					

Wahler Associates

ANDERSON DAM
SPILLWAY ENLARGEMENT

EXPLORATION BORING LOG			BORING NO.
PROJECT NO. SCV-124A	SHEET NO. 1 OF 2		AD-7

BORING LOCATION			GROUND EL.
DEPTH/ELEV. WATER		DRILL CONTRACTOR	TOTAL DEPTH
DRILL RIG	BORING DIA.	DATE DRILLED	LOGGED BY -

SOIL CLASS.	DESCRIPTION	DEPTH	SAMPLE NO.	PR / RQD	REC.	MODE	REMARKS
	FRANCISCAN FM.						
CL	19.0 - 21.5 CRUSHED, ALTERED SANDSTONE; grey, grey green; moist; soil-like, very stiff to hard gravelly, sandy clay w/ friable sandstone pieces; probably a shear zone.	20	B-4	35 13 17	1.0 1.5	DR	20.0 - 21.5 SPT. 21.5 Terminate hole.
		22					Fill hole w/ cuttings.
	TOTAL DEPTH 21.5'						
		24					
		26					

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Wahler Associates

EXPLORATION BORING LOG			BORING NO.
PROJECT NO.	SHEET NO.		
SCV-174A	2 OF 2		AD-7

BORING LOCATION Station 11+18, 135' Lt. of ℄.			GROUND EL. 555
DEPTH/ELEV. WATER 17.5' 8/9/83	DRILL CONTRACTOR Weyer		TOTAL DEPTH 25.7
DRILL RIG Mob.l B-40L	BORING DIA. 0.5'	DATE DRILLED 8/9/83	LOGGED BY ES

SOIL CLASS.	DESCRIPTION	DEPTH	SAMPLE NO.	PR / RQD	REC.	MODE	REMARKS
SC	FILL 0.0 - 13.0 GRAVELLY CLAYEY SAND: gray; 25%-35% fines, mod. plastic; slightly damp to moist; moist @ 10'; derived from serpentine.	0				AD	Drill w/ 6" flight auger
		2					
		4					
		6					
		8					
		10					
		12					
SC	TERRACE DEPOSIT 13.0 - 21.0 GRAVELLY CLAYEY SAND: medium brown - red brown; 30% - 35% fines, mod. plastic; 5%-15% gravel, fine to coarse, sub. rnd. - sub ang.; moist - wet.	14	S-1		2.5/2.5	P	13.0 - 15.5 Push 3" liner; 600 psi; Sample may be disturbed.
		16				AD	15.0 - 18.0 encounter water.
		18	S-2		1.4/1.4	P	17.3 - 18.7 Push 3" liner; refuse @ 1200 psi. Tube damaged.
	19.0 Thin silt lense red brown.					AD	
		20					

Wahler Associates

ANDERSON DAM
SPILLWAY ENLARGEMENT

EXPLORATION BORING LOG		BORING NO.
PROJECT NO. SCV-124A	SHEET NO. 1 OF 2	AD-8

BORING LOCATION
GROUND EL.
DEPTH/ELEV. WATER
DRILL CONTRACTOR
TOTAL DEPTH
DRILL RIG
BORING DIA.
DATE DRILLED
LOGGED BY

SOIL CLASS.	DESCRIPTION	DEPTH	SAMPLE NO.	PR / RQD	REC.	MODE	REMARKS
SC	TERRACE DEPOSIT 13.0 - 21.0 GRAVELLY CLAYEY SAND: (cont'd).	20				AD	
GC	FRANCISCAN FM. 21.0 - 25.7 SHALE: black - dark gray; damp; crushed; friable; weak; soft where wet,	22					21.0 shale returns on augur.
		24					
			B-1	31 50/.2	0.7 0.7	DR	25.0 - 25.7 Standard penetration test; 140# hammer, 30" drop. 25.7 Terminate hole.
	TOTAL DEPTH 25.7'	26					
		28					
		30					

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Wahler Associates

EXPLORATION BORING LOG

PROJECT NO.	SHEET NO.	BORING NO.
SCV-124A	2 OF 2	AD-8

BORING LOCATION Station 5+25, 79' Lt. of ℄.
GROUND EL. 597
DEPTH/ELEV. WATER *6' 8/9/83
DRILL CONTRACTOR Weyer
TOTAL DEPTH 36.5
DRILL RIG Mobil B-40L
BORING DIA. 0.5'
DATE DRILLED 8/9/83
LOGGED BY CS

SOIL CLASS.	DESCRIPTION	DEPTH	SAMPLE NO.	PR / RQD	REC.	MODE	REMARKS
	COLLUVIUM	0					
CL-CH	0.0 - 14.5 GRAVELLY SANDY CLAY: dark brown - red brown; damp - moist; 5%-15% sand, v. fine - fine; some gravel, angular - sub-angular.	2				AD	Drill w/ 6" flight auger.
		4					
		6					
	7.5 - 8.0 Coarse gravel, cobbles w/ clay.	8					
		10					
		12					
		14					
	TERRACE DEPOSIT						
SC	14.5 - 24.0 GRAVELLY SANDY CLAY: red brown; moist - v. moist; 5%-15% gravel, fine - cse.; ang. - sub.ang.; 30%-40% fines, slightly - mod. plastic; fine - med. sand; old colluvial deposit; v. dense.	16	B-1		1.1 / 1.7	P	15.0-16.7 Push 3" liner; bottom 0.7' smashed.
						AD	*15.0 Encounter water.
		18					
		20					

Wahler Associates

ANDERSON DAM
SPILLWAY ENLARGEMENT

EXPLORATION BORING LOG
PROJECT NO. SCV-124A
SHEET NO. 1 OF 2
BORING NO. AD-9

BORING LOCATION			GROUND EL.
DEPTH/ELEV. WATER	DRILL CONTRACTOR		TOTAL DEPTH
DRILL RIG	BORING DIA.	DATE DRILLED	LOGGED BY -

SOIL CLASS.	DESCRIPTION	DEPTH	SAMPLE NO.	PR / RQD	REC.	MODE	REMARKS
SC	TERRACE DEPOSIT 14.5 – 24.0 GRAVELLY CLAYEY SAND: cont'd.	20	B-2	26 31 32	1.0 / 1.5	DR	20.0-21.5 Standard penetration test; 140# hammer, 30" drop.
						AD	
		22					
GC	FRANCISCAN FM. 24.0 – 36.5 SERPENTINE: grey green; crushed, friable but with hard frags. To 0.1'; breaks down to clayey gravel (GC)	24					24.0 – 25.0 Drills as if "fractured"; gray brown w/ much serpentine detritus. Water rose to 6' depth.
		26					
		28					
		30					
		32					
		34					
			B-3	16 19 14	1.0 / 1.5	DR	35.0 – 36.5 SPT. 36.5 Terminate hole.
		36					
	TOTAL DEPTH 36.5'						Backfill hole w/ cuttings.

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Wahler Associates	EXPLORATION BORING LOG		BORING NO.
	PROJECT NO. SCV-124A	SHEET NO. 2 OF 2	AD-9

BORING LOCATION Dam Crest: 10' Rt. of ₵. opp. coord. IN 3267' *			GROUND EL. 640
DEPTH/ELEV. WATER Not Encountered	DRILL CONTRACTOR Weyer		TOTAL DEPTH 10.0'
DRILL RIG Mobil B-40L	BORING DIA. 0.5'	DATE DRILLED 8/12/83	LOGGED BY ES

SOIL CLASS.	DESCRIPTION	DEPTH	SAMPLE NO.	PR / RQD	REC.	MODE	REMARKS
GC SC	CREST ROAD 0.0 – 0.1' ASPHALT CONCRETE ROAD BASE 0.1 – 0.4' CLAYEY GRAVEL: ang. gravel.	0	1.5 B-1			AD	Drill w/ 6" flight auger.
	EMBANKMENT ZONE 3 0.4 – 10.0 GRAVELLY CLAYEY SAND: Tan; moist; 5%-15% gravel, fine, ang.-sub.ang.; 30%-35% fines, slightly-mod. plastic; 55%-65% sand, fine-med.	2	B-2 R-1	14 26 25	1.0/1.5	DR	2.0-3.5 Drive 3" OD ring sampler: 140# hammer, 30" drop.
		4				AD	
		6	B-3 R-2	17 25 27	1.0/1.5	DR	5.0-6.5 Drive 3" OD ring sampler (2 3/8" ID).
						AD	
		8					
			B-4 R-3	16 30 34	1.1/1.5	DR	8.5-10.0 Drive 3" OD ring sampler.
	TOTAL DEPTH 10.0'	10					10.0 Terminate hole. Backfill hole w/ cuttings; patch road w/ Sackcrete Blacktop.

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* See Figure

Wahler Associates	ANDERSON DAM SPILLWAY ENLARGEMENT	EXPLORATION BORING LOG		BORING NO.
		PROJECT NO. SCV-124A	SHEET NO. 1 OF 1	AD-10

BORING LOCATION Dam Crest: 10' Rt. of ℄ opp. coord. N 3552 *			GROUND EL. 640
DEPTH/ELEV. WATER Not Encountered	DRILL CONTRACTOR Weger		TOTAL DEPTH 10.0
DRILL RIG Mobil B-40L	BORING DIA. 0.5'	DATE DRILLED 8/12/83	LOGGED BY ES

SOIL CLASS.	DESCRIPTION	DEPTH	SAMPLE NO.	PR / RQD	REC.	MODE	REMARKS
GC SC	CREST ROAD 0.0 - 0.1' ASPHALT CONCRETE: ROAD BASE 0.1' - 0.5' CLAYEY GRAVEL: damp; ang. gravel.	0				AD	Drill w/ 6" flight auger.
	EMBANKMENT ZONE 3 0.5 - 10.0 GRAVELLY CLAYEY SAND: Tan; moist; 5%-15% gravel, fine - cse; ang. - sub. rnd.; 25%-30% fines, slightly - mod. plastic; fine - cse. sand.	2	B-1 R-1	11 8 11	0.7/1.5	DR	2.0 - 3.5 Drive 3" OD, (2 3/8" ID) ring sampler: 140# hammer, 30" drop. Hole measured 2.0' before drive, 3.5' after drive, but recovered only 0.7', suspect compression
		4				AD	
		6	S-1		1.4/2.5	P	5.0 - 7.5 Push 3" liner; bottom of liner smashed. Hole measured 5.0' before, 6.5' after push.
		8				AD	
			B-2 R-2	22 19 15	0.8/1.5	DR	8.5 - 10.0 Drive 3" OD ring sampler. Hole measured 8.5' before, 10.0' after drive.
	TOTAL DEPTH 10.0'	10					10.0' Terminate hole. Backfill hole w/ cuttings; patch road w/ Sackrete Blacktop.

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* See Figure

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		PROJECT NO. SCV-124A	SHEET NO. 1 OF 1	AD-11

BORING LOCATION Dam Crest: 10' Rt. of ℄ opp. coord. N 3852*			**GROUND EL.** 640
DEPTH/ELEV. WATER Not Encountered	**DRILL CONTRACTOR** Weyer		**TOTAL DEPTH** 10.0'
DRILL RIG Mobil B-40L	**BORING DIA.** 0.5'	**DATE DRILLED** 8/12/83	**LOGGED BY** ES

SOIL CLASS.	DESCRIPTION	DEPTH	SAMPLE NO.	PR / RQD	REC.	MODE	REMARKS
	CREST ROAD 0.0 – 0.1' ASPHALT CONCRETE: ROAD BASE	0				AD	Drill w/ 6" flight auger
GC	0.1' – 1.5 CLAYEY GRAVEL: damp; ang. gravel.						
	EMBANKMENT ZONE 3		B-1				
SC	1.5 – 7.0 GRAVELLY CLAYEY SAND: tan; moist; 10%-20% gravel, ang.-sub rnd., fine-cse.; 25% - 35% fines, slightly plastic; fine-cse. sand.	2					
			*B-2 R-1	21 31 50	1.5 / 1.5	DR	2.7 - 4.2 Drive 3" OD (2 3/8 ID) ring sampler, 140# hammer, 30" drop.
		4					
			B-3			AD	
		6	B-4 R-2	21 37 50	1.2 / 1.5	DR	5.2 - 6.7 Drive 3" OD ring sampler. Lowest 2 rings may be disturbed.
GC	7.0 - 9.7 SANDY CLAYEY GRAVEL: dark brown; 50% - 60% gravel, sub ang - sub rnd.; 15% - 25% slightly plastic fines.					AD	7.0 - 8.5 Rough drill action.
		8	B-5				
			B-6 R-3 B-6	38 47 50/.2	1.1 / 1.5	DR	8.5 - 9.7 Drive 3" OD ring sampler. Bottom ring disturbed replaced material @ top end.
		10					9.7 Terminate hole. Backfill hole w/ drill cuttings; patch w/ Sackrete BlackTop

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* See Figure

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BORING LOCATION Dam Crest: 10' Rt. of ℄ opp. coord. N 4136*		GROUND EL. 640
DEPTH/ELEV. WATER Not Encountered	DRILL CONTRACTOR Weyer	TOTAL DEPTH 10.0'
DRILL RIG Mobil B-40L	BORING DIA. 0.5' DATE DRILLED 8/12/83	LOGGED BY CS

SOIL CLASS.	DESCRIPTION	DEPTH	SAMPLE NO.	PR / RQD	REC.	MODE	REMARKS
	CREST ROAD 0.0 - 0.1 ASPHALT CONCRETE	0				AD	
GC	ROAD BASE 0.1 - 2.5						
			B-1				
		2					
SC-CL	EMBANKMENT ZONE 3 2.5 – 6.0 GRAVELLY CLAYEY SAND; Tan; moist; 5%-15% gravel, sub.ang. - sub rnd., fine - cse.; 25% - 40% fines, mod. plastic; contains lifts of clay.		B-2				
			B-3	6	1.5	DR	3.3 - 4.8 Drive 3" OD ring sampler.
CL-CH		4	R-1	8	1.5		
			R-2	11			
SC	4.1 – 4.4 Sandy clay: red brown; moist; mod. plastic.					AD	
			B-4				6.0 - 8.5 Rough drilling
		6	B-5	20	1.5	DR	6.0 - 7.5 Drive 3" OD ring sampler.
SC-GC	6.0 – 10.0 SANDY CLAYEY GRAVEL – GRAVELLY CLAYEY SAND: dark brown; moist; 30% - 60% gravel, fine - cse; 15% - 30% fines, slightly - mod. plastic; 25% - 55% sand, fine - cse; contains lifts of silty gravel		R-3	24	1.5		
			R-4	32			
		8				AD	
			B-6				
			B-7	34		DR	8.5 - 10.0 Drive 3" OD ring sampler
				34			
GM SC			R-5	30			
		10	B-7				
	TOTAL DEPTH 10.0.						10.0' Terminate hole. Backfill hole w/ drill cuttings; patch w/ Sackcrete Blacktop

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* See Figure

Wahler Associates	ANDERSON DAM SPILLWAY ENLARGEMENT	EXPLORATION BORING LOG PROJECT NO. SCV-1244 SHEET NO. 1 OF 1	BORING NO. AD-13

PIEZOMETER DATA SHEETS

Santa Clara Valley Water District

PIEZOMETER DATA SHEET

FC 613 (12-27-79)

LOCATION AND TYPE

(1) Facility Anderson Dam Piezometer No. AD-1

(2) Area Levee crest, left side of spillway.

(3) Station & Offset or Coordinates 105' left of Sta. 3+10 Existing spillway ℄ (map and field measurement)

(4) Ground Surface Elevation Directly Above Tip 640.5'

(5) Type ☐ Pneumatic ☑ Open Well

(6) Manufacturer and Model 10' section, 2"Φ Sch. 40 PVC with 0.10" machine cut slots (Hydrophilic Industries, Inc; WA)

REFERENCE DATA FOR PNEUMATIC PIEZOMETERS

(7) Tip Depth Below Ground Surface

(8) Tip Elevation

(9) Sensing Zone Elevation Range to

REFERENCE DATA FOR OPEN WELL PIEZOMETERS

(10) Reference Point Top of 4"Φ steel surface casing.

(11) Reference Point Elevation 642.0'

(12) Tip Depth Below R.P. 44.5' Below Ground Surface 43.0'

(13) Tip Elevation 597.5'

(14) Sensing Zone Elevation Range 612.5' to 597.5'

INSTALLATION

(15) Date Installed July 19, 1983 By Wahler Associates

(16) Report Describing Installation

(17) Identification When Installed Piezometer number and date of installation marked on 2" plastic cap; Piezo number marked on 4"Φ steel casing.

(18) Purpose Ground water level monitoring along proposed spillway enlargement.

READING AND CALCULATION DATA

(19) Scheduled Readings Monthly to Dec 1983

(20) Piezometer Equation (Customary Units) Depth and elevation of water level in feet.

(21) Piezometer Equation (With Conversion of Metric Readings to Customary)

COMMENTS

Backfill drain material consists of No. 3 clean, Kiln-dried Monterey sand. from 28' to 45' (below ground surface); 1-ft bentonite plug, 27'-28'; Native backfill to surface. Install 4"Φ surface steel casing with locking protective cover ("x" lock).

BY:

Date:

Santa Clara Valley Water District

PIEZOMETER DATA SHEET
FC 613 (12-27-79)

LOCATION AND TYPE

(1) Facility Anderson Dam Spillway Piezometer No. AD-2

(2) Area Left side existing spillway (lined) channel.

(3) Station & Offset or Coordinates 116' left of Sta. 4+11, Existing spillway ℄ (map and field measurement)

(4) Ground Surface Elevation Directly Above Tip 630.1'

(5) Type ☐ Pneumatic ☑ Open Well

(6) Manufacturer and Model 5' section, 2" ⌀ Sch. 40 PVC with 0.10" machine cut slots (Hydrophilic Industries, Inc., WA)

REFERENCE DATA FOR PNEUMATIC PIEZOMETERS

(7) Tip Depth Below Ground Surface

(8) Tip Elevation

(9) Sensing Zone Elevation Range to

REFERENCE DATA FOR OPEN WELL PIEZOMETERS

(10) Reference Point Top of 4" ⌀ steel surface casing.

(11) Reference Point Elevation 631.8'

(12) Tip Depth Below R.P. 41.6' Below Ground Surface 39.9'

(13) Tip Elevation 590.2'

(14) Sensing Zone Elevation Range 600.1' to 590.1'

INSTALLATION

(15) Date Installed July 20, 1983 By Wahler Associates

(16) Report Describing Installation

(17) Identification When Installed Piezometer number and date of installation marked on 2" plastic cap; Piezo number marked on 4" ⌀ steel casing.

(18) Purpose Ground water level monitoring along proposed spillway enlargement.

READING AND CALCULATION DATA

(19) Scheduled Readings Monthly through Dec 1983

(20) Piezometer Equation (Customary Units) Water level depth and elevation in feet.

(21) Piezometer Equation (With Conversion of Metric Readings to Customary)

COMMENTS

Filter backfill consists of No. 3 clean, Kiln-dried Monterey sand from 30' to 40' below ground surface. 1-ft bentonite plug 29'-30'; Native backfill to surface. Install 4" ⌀ surface steel casing with locking protective cover ("x" lock).

BY:

Date:

Santa Clara Valley Water District

PIEZOMETER DATA SHEET

FC 613 (12-27-79)

LOCATION AND TYPE

(1) Facility *Anderson Dam Spillway* Piezometer No. *AD-3*

(2) Area *Left side existing lined spillway channel.*

(3) Station & Offset or Coordinates *78' left of Sta. 6+04, Existing spillway ℄ (map and field measurement)*

(4) Ground Surface Elevation Directly Above Tip *591.8'*

(5) Type ☐ Pneumatic ☑ Open Well

(6) Manufacturer and Model *5' section, 2" ϕ Sch. 40 PVC with 0.10" machine cut slots (Hydrophilic Industries, Inc, WA)*

REFERENCE DATA FOR PNEUMATIC PIEZOMETERS

(7) Tip Depth Below Ground Surface

(8) Tip Elevation

(9) Sensing Zone Elevation Range to

REFERENCE DATA FOR OPEN WELL PIEZOMETERS

(10) Reference Point *Top of 4" ϕ steel surface casing.*

(11) Reference Point Elevation *594.3'*

(12) Tip Depth Below R.P. *31.6'* Below Ground Surface *29.1'*

(13) Tip Elevation *562.7'*

(14) Sensing Zone Elevation Range *573.8'* to *562.7'*

INSTALLATION

(15) Date Installed *July 21, 1983* By *Wahler Associates*

(16) Report Describing Installation

(17) Identification When Installed *Piezometer number and date of installation marked on 2" plastic cap. Piezo number marked on 4" ϕ surface steel casing.*

(18) Purpose *Ground water level monitoring along proposed spillway enlargement.*

READING AND CALCULATION DATA

(19) Scheduled Readings *Monthly through Dec 1983*

(20) Piezometer Equation (Customary Units) *Water level depth and elevation in feet.*

(21) Piezometer Equation (With Conversion of Metric Readings to Customary)

COMMENTS

Filter drain material consists of No. 3 clean, Kiln dried Monterey sand from 18'-30'; Bentonite seal from 17'-18'; Native backfill to surface. Install 4" ϕ surface steel casing with locking protective cover ("x" lock).

BY:

Date:

Santa Clara Valley Water District

PIEZOMETER DATA SHEET

FC 613 (12-27-79)

LOCATION AND TYPE

(1) Facility Anderson Dam Spillway Piezometer No. AD-4

(2) Area Left side existing lined spillway channel.

(3) Station & Offset or Coordinates 72' Left of Sta. 8+01 Existing Spillway ℄ (map and field measurement)

(4) Ground Surface Elevation Directly Above Tip 576.4'

(5) Type ☐ Pneumatic ☑ Open Well

(6) Manufacturer and Model 5' section 2" ϕ Sch. 40 PVC with hand sawed spiral slots. 3" apart.

REFERENCE DATA FOR PNEUMATIC PIEZOMETERS

(7) Tip Depth Below Ground Surface

(8) Tip Elevation

(9) Sensing Zone Elevation Range to

REFERENCE DATA FOR OPEN WELL PIEZOMETERS

(10) Reference Point Top of 4" ϕ steel surface casing.

(11) Reference Point Elevation 578.1'

(12) Tip Depth Below R.P. 31.4' Below Ground Surface 29.7'

(13) Tip Elevation 546.7'

(14) Sensing Zone Elevation Range 563.4' to 546.7'

INSTALLATION

(15) Date Installed July 22, 1983 By Wahler Associates

(16) *Report Describing Installation*

(17) Identification When Installed Piezometer number and date of installation marked on 2" plastic cap. Piezo number marked on 4" ϕ surface steel casing.

(18) Purpose Ground water level monitoring along proposed spillway enlargement.

READING AND CALCULATION DATA

(19) Scheduled Readings Monthly through Dec 1983.

(20) Piezometer Equation (Customary Units) Water level depth and elevation in feet.

(21) Piezometer Equation (With Conversion of Metric Readings to Customary)

COMMENTS

Filter drain material consists of No. 3 clean, Kiln dried Monterey sand from 13'-32'; Bentonite plug 12'-13'; Native backfill to surface; Install 4" ϕ surface steel casing with locking protective cover ("X" lock).

BY:

Date:

Santa Clara Valley Water District

PIEZOMETER DATA SHEET

FC 613 (12-27-79)

LOCATION AND TYPE

(1) Facility Anderson Dam Spillway Piezometer No. AD-5

(2) Area Left side existing lined spillway channel.

(3) Station & Offset or Coordinates 71' Left of Sta. 10+93 Existing spillway ℄ (map and field measurement)

(4) Ground Surface Elevation Directly Above Tip 552.5'

(5) Type ☐ Pneumatic ☑ Open Well

(6) Manufacturer and Model 5' section 2" φ Sch. 40 PVC with hand sawed spiral slots 3" apart.

REFERENCE DATA FOR PNEUMATIC PIEZOMETERS

(7) Tip Depth Below Ground Surface

(8) Tip Elevation

(9) Sensing Zone Elevation Range to

REFERENCE DATA FOR OPEN WELL PIEZOMETERS

(10) Reference Point Top of 4" φ steel surface casing.

(11) Reference Point Elevation 554.0'

(12) Tip Depth Below R.P. 31.0' Below Ground Surface 29.5'

(13) Tip Elevation 523.0'

(14) Sensing Zone Elevation Range 531.5' to 523.0'

INSTALLATION

(15) Date Installed July 25, 1983 By Wahler Associates

(16) Report Describing Installation

(17) Identification When Installed Piezometer number and date of installation marked on 2" plastic cap. Piezo number marked on 4" φ surface steel casing.

(18) Purpose Ground water level monitoring along proposed spillway enlargement.

READING AND CALCULATION DATA

(19) Scheduled Readings Monthly through Dec 1983

(20) Piezometer Equation (Customary Units) Water level depth and elevation in feet.

(21) Piezometer Equation (With Conversion of Metric Readings to Customary)

COMMENTS

Filter drain material consists of No. 3 clean, Kiln dried Monterey sand, 21'-30';
Bentonite plug 20'-21'. Native backfill to surface; Install 4" φ surface
steel casing with locking protective cover ("X" lock).

BY:

Date:

FIELD DENSITY
TEST RESULTS

TABLE A-1

RESULTS OF FIELD DENSITY TESTS

Test	Test Pit No.	Material Type	Depth (ft.)	Dry Density (pcf)	Water Content (%)
1	TP-20	Fill (SC/CL)	2.5	103.3	17.6
2	TP-20	Fill (SC)	6.0	123.6	10.1
3	TP-21	Terrace Deposit	4.0	96.5	19.4
4	TP-22	Terrace Deposit	4.0	98.6	23.2
5	TP-22	Terrace Deposit	6.5	97.9	19.5
6	TP-23	Colluvium	4.0	85.5	26.8
7	TP-23	Colluvium	6.0	105.7	29.0
8	TP-24	Slopewash	2.0	87.6	21.8

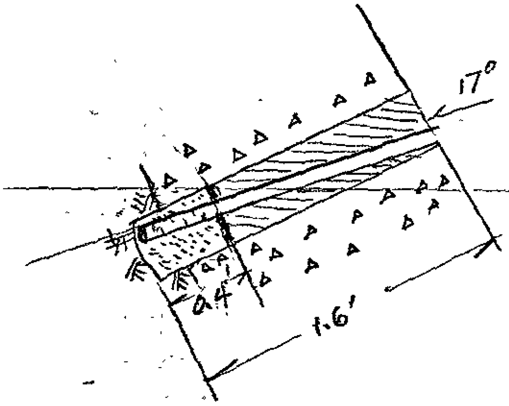
NOTE: See Figure III-2 for location of test pits.

CONCRETE CORE LOGS
EXISTING SPILLWAY

BORING LOCATION Spwy. Sta 4+51, rt. wall, 5.0' Slope ht. (up)
GROUND EL.
DEPTH/ELEV. WATER Not encountered
DRILL CONTRACTOR Cal-West
TOTAL DEPTH 1.6'
DRILL RIG Diamond Products
BORING DIA. 4"
DATE DRILLED 10/5/83
LOGGED BY ES

SOIL CLASS.	DESCRIPTION	DEPTH	SAMPLE NO.	PR / RQD	REC.	MODE	REMARKS
	CONCRETE 0.0 - 1.5 CONCRETE: gray; hard; v. strong; transverse crack (prob. mechanical) @ 0.1 (not through going), and 0.65 (rebar); long longitudonal crack (Tension). 0.0 - 0.2, 0.05 - 0.2, attached to serp. bedrock; apparently good contact.	0 1					Hole inclined 25° down. 0.0 - 1.6 Concrete core w/4" barrel, water.
	1.5 - 1.6 SERDENTINE; hard rock fragments recoverd on end of concrete core; intensely fractured; iron stain, clay on fracture surfaces; mod. hard; weak.	2 3					1.6 Terminate hole. Description based on mat'ls attached to concrete and by inspection of the hole.
	TOTAL DEPTH 1.6'	4					

Backfill procedure; performed Oct 12, 1983.



SEE EXPLANATION DH 7-3 LOG.

DATA ON THIS LOG ARE AN APPROXIMATION OF THE GEOLOGIC AND SUBSURFACE CONDITIONS BECAUSE THE INFORMATION WAS OBTAINED FROM INDIRECT, DISCONTINUOUS, AND POSSIBLY DISTURBED SAMPLING NECESSITATED BY USE OF SMALL-DIAMETER HOLES. ROTARY AND WASH BORING HOLES HAVE FURTHER COMPLICATIONS IN THIS REGARD BECAUSE OF THE NEED TO USE DRILLING FLUID AND/OR CASING IN ADVANCING HOLES.

THIS LOG INDICATES CONDITIONS IN THIS HOLE ONLY ON THE DATE INDICATED AND MAY NOT REPRESENT CONDITIONS AT OTHER LOCATIONS AND ON OTHER DATES. ANY WATER LEVELS SHOWN ARE SUBJECT TO VARIATION.

THIS HOLE WAS LOGGED IN SUCH A WAY AS TO PROVIDE DATA PRIMARILY FOR DESIGN PURPOSES AND NOT NECESSARILY FOR THE PURPOSES OF SPECIFIC CONTRACTORS.

THE STRATIFICATION LINES OR DEPTH INTERVALS REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN MATERIAL TYPES, AND THE TRANSITIONS MAY BE GRADUAL.

SOIL CLASSIFICATIONS SHOWN ON LOGS ARE FIELD CLASSIFICATIONS BASED ON THE UNIFIED SOILS CLASSIFICATION SYSTEM.

Wahler Associates

ANDERSON DAM
SPILLWAY ENLARGEMENT

EXPLORATION BORING LOG
PROJECT NO. SCV-174A
SHEET NO. 1 OF 1
BORING DH 5-

BORING LOCATION Spwy. Sta 4+51, rt. wall, 2.2 ' slope ht. (up)		GROUND EL.
DEPTH/ELEV. WATER Not encountered	DRILL CONTRACTOR Cal-West	TOTAL DEPTH 1.6
DRILL RIG Diamond Products	BORING DIA. 4"	DATE DRILLED 10/5/83
		LOGGED BY ES

SOIL CLASS.	DESCRIPTION	DEPTH	SAMPLE NO.	PR / RQD	REC.	MODE	REMARKS
	CONCRETE	0					
	0.0 – 1.6 CONCRETE: gray; hard; v. strong; transverse cracks (prob. mechanical) @ 0.55, 0.75, attached to serpentine bedrock; apparently good contact.	1	X-1		1.6/1.6	C	0.0 – 1.6 Concrete core w/ 4" barrel, water. 1.6 Terminate hole
	TOTAL DEPTH 1.6'						
	1.6 SERPENTINE: green, yellow; intensely fractured; weak; mod. hard; clay on fracture surfaces.	2 3					Description from materials attached to concrete and by inspection of the hole.
		4					
	Hole completely backfilled with hand packed mortar mix, Oct 12, 1983.						

DATA ON THIS LOG ARE AN APPROXIMATION OF THE GEOLOGIC AND SUBSURFACE CONDITIONS BECAUSE THE INFORMATION WAS OBTAINED FROM INDIRECT, DISCONTINUOUS, AND POSSIBLY DISTURBED SAMPLING NECESSITATED BY USE OF SMALL-DIAMETER HOLES. ROTARY AND WASH BORING HOLES HAVE FURTHER COMPLICATIONS IN THIS REGARD BECAUSE OF THE NEED TO USE DRILLING FLUID AND/OR CASING IN ADVANCING HOLES.

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THIS HOLE WAS LOGGED IN SUCH A WAY AS TO PROVIDE DATA PRIMARILY FOR DESIGN PURPOSES AND NOT NECESSARILY FOR THE PURPOSES OF SPECIFIC CONTRACTORS.

THE STRATIFICATION LINES OR DEPTH INTERVALS REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN MATERIAL TYPES, AND THE TRANSITIONS MAY BE GRADUAL.

SOIL CLASSIFICATIONS SHOWN ON LOGS ARE FIELD CLASSIFICATIONS BASED ON THE UNIFIED SOILS CLASSIFICATION SYSTEM.

Wahler Associates

ANDERSON DAM
SPILLWAY ENLARGEMENT

EXPLORATION BORING LOG

PROJECT NO. SCV-124A

SHEET NO. 1 OF 1

BORIN

DH5

BORING LOCATION Spwy. Sta 5+41, rt. wall, 6.5' slope ht (up).		GROUND EL.
DEPTH/ELEV. WATER Not encountered	DRILL CONTRACTOR Cal-West	TOTAL DEPTH 2.55
DRILL RIG Diamond Products	BORING DIA. 4" / DATE DRILLED 10/5/83	LOGGED BY ES

SOIL CLASS.	DESCRIPTION	DEPTH	SAMPLE NO.	PR / RQD	REC.	MODE	REMARKS
	CONCRETE	0					Hole inclined 25°-down.
	0.0 - 1.2 CONCRETE: gray; hard; v. strong; rebar @ 0.8' from face; no cracks.		X-1		100% 1.2/1.2	C	0.0 - 1.2 Concrete core w/ 4" barrel; water.
		1					
SC	SLOPEWASH 1.2 - 2.55 GRAVELLY CLAYEY SAND: red brown; damp - moist; apparently dense; 20% - 25% fines, slight - mod. plasticity.		B-1		0.2/1.15		1.2 - 2.35 Attempt soil sample w/ 4" barrel; water.
		2		B-2			2.35 - 2.55 Hand auger
				B-3		A	
	TOTAL DEPTH 2.55'						2.55 Terminate hole.
		3					
	Hole backfilled with hand packed mortar mix on Oct 12, 1983.	4					
		5					

DATA ON THIS LOG ARE AN APPROXIMATION OF THE GEOLOGIC AND SUBSURFACE CONDITIONS BECAUSE THE INFORMATION WAS OBTAINED FROM INDIRECT, DISCONTINUOUS, AND POSSIBLY DISTURBED SAMPLING NECESSITATED BY USE OF SMALL-DIAMETER HOLES. ROTARY AND WASH BORING HOLES HAVE FURTHER COMPLICATIONS IN THIS REGARD BECAUSE OF THE NEED TO USE DRILLING FLUID AND/OR CASING IN ADVANCING HOLES.

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THIS HOLE WAS LOGGED IN SUCH A WAY AS TO PROVIDE DATA PRIMARILY FOR DESIGN PURPOSES AND NOT NECESSARILY FOR THE PURPOSES OF SPECIFIC CONTRACTORS.

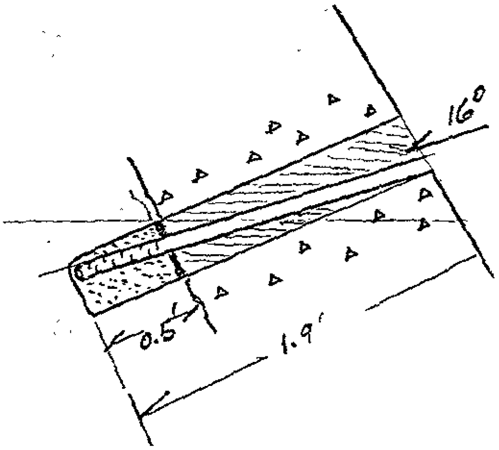
THE STRATIFICATION LINES OR DEPTH INTERVALS REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN MATERIAL TYPES, AND THE TRANSITIONS MAY BE GRADUAL.

SOIL CLASSIFICATIONS SHOWN ON LOGS ARE FIELD CLASSIFICATIONS BASED ON THE UNIFIED SOILS CLASSIFICATION SYSTEM.

Wahler Associates	ANDERSON DAM SPILLWAY ENLARGEMENT	EXPLORATION BORING LOG		BORIN[redacted]
		PROJECT NO. SCV-124A	SHEET NO. 1 OF 1	DH

BORING LOCATION Spwy. Sta. 5+41, rt. wall, 4.2' slope ht. (up)		GROUND EL.
DEPTH/ELEV. WATER Not encountered	DRILL CONTRACTOR Cal-West	TOTAL DEPTH 1.9
DRILL RIG Diamond Products	BORING DIA. 4"	DATE DRILLED 10/5/83	LOGGED BY ES

SOIL CLASS.	DESCRIPTION	DEPTH	SAMPLE NO.	PR / RQD	REC.	MODE	REMARKS
	CONCRETE						Hole inclined @ 25° - down
	0.0 – 1.35 CONCRETE; gray; hard; v. strong; rebar @ 0.7', cracks @ 0.05' (surface patch), 1.0' (Transverse), 0.05-0.2' (longitudonal).	0 1	X-1		1.35 1.35	C	0.0 - 1.35 Concreto core w/ 4" barrel; water.
SC	SLOPEWASH 1.35- 1.90 CLAYEY SAND: red brown; damp; apparently dense; 20%-25% fines; slightly - mod. plastic; apparently good contact w/ concrete.	2	B-1 B-2			DR	1.35-1.55 Drive 3" Shelby w/18# hammer. Disturbed. 1.60-1.90 Drive 3" Shelby w/18# hammer. Sample disturbed.
	TOTAL DEPTH 1.9'	3					1.90 Terminate hole
		4					
	Backfill procedure performed 10/12/83	5					



- SEE EXPLANATION DH-7-3 LOG.

DATA ON THIS LOG ARE AN APPROXIMATION OF THE GEOLOGIC AND SUBSURFACE CONDITIONS BECAUSE THE INFORMATION WAS OBTAINED FROM INDIRECT, DISCONTINUOUS, AND POSSIBLY DISTURBED SAMPLING NECESSITATED BY USE OF SMALL-DIAMETER HOLES. ROTARY AND WASH BORING HOLES HAVE FURTHER COMPLICATIONS IN THIS REGARD BECAUSE OF THE NEED TO USE DRILLING FLUID AND/OR CASING IN ADVANCING HOLES.

THIS LOG INDICATES CONDITIONS IN THIS HOLE ONLY ON THE DATE INDICATED AND MAY NOT REPRESENT CONDITIONS AT OTHER LOCATIONS AND ON OTHER DATES. ANY WATER LEVELS SHOWN ARE SUBJECT TO VARIATION.

THIS HOLE WAS LOGGED IN SUCH A WAY AS TO PROVIDE DATA PRIMARILY FOR DESIGN PURPOSES AND NOT NECESSARILY FOR THE PURPOSES OF SPECIFIC CONTRACTORS.

THE STRATIFICATION LINES OR DEPTH INTERVALS REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN MATERIAL TYPES, AND THE TRANSITIONS MAY BE GRADUAL.

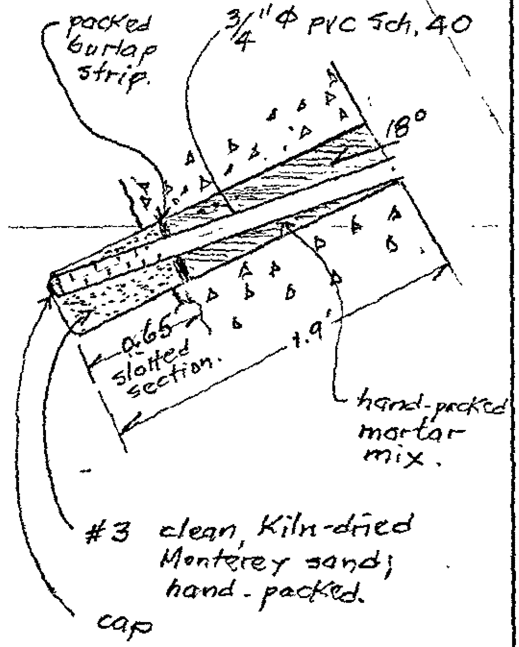
SOIL CLASSIFICATIONS SHOWN ON LOGS ARE FIELD CLASSIFICATIONS BASED ON THE UNIFIED SOILS CLASSIFICATION SYSTEM.

Wahler Associates	ANDERSON DAM SPILLWAY ENLARGEMENT	EXPLORATION BORING LOG	BORI
		PROJECT NO. SCV-124A	SHEET NO. 1 OF 1	DH 7

BORING LOCATION Spwy. Sta. 5+41, rt. wall, 1.5' Slope ht. (up)		GROUND EL.
DEPTH/ELEV. WATER Not encountered	DRILL CONTRACTOR Cal-West	TOTAL DEPTH 1.9
DRILL RIG Diamond Product BORING DIA. 4"	DATE DRILLED 10/5/83	LOGGED BY ES

SOIL CLASS.	DESCRIPTION	DEPTH	SAMPLE NO.	PR / RQD	REC.	MODE	REMARKS
	CONCRETE 0.0 - 1.35 CONCRETE; gray; hard; v. strong, transverse cracks (prob. mechanical) @ 0.6' and 1.2'; longitudonal crack (tension ?) 0.0 - 0.25'.	0 1	X-1		1.35/1.35	C	Hole inclined @ 25° 0.0 - 1.35 Concrete core w/4" barrel; water
			B-1				DR 1.35 - 1.5: drive 2" split spoon sampler 50 blows w/ 8# hammer.
SC	SLOPEWASH 1.35 - 1.9 CLAYEY SAND: red brown; damp; apparently dense; 20% 25% fines, slight - mod. plasticity; apparently good contact w/concrete.	2 3	B-2			A	1.5 - 1.9 hand auger 1.9 Terminate hol
	TOTAL DEPTH 1.9'	4					

Backfill procedure; performed 10/12/83.



DATA ON THIS LOG ARE AN APPROXIMATION OF THE GEOLOGIC AND SUBSURFACE CONDITIONS BECAUSE THE INFORMATION WAS OBTAINED FROM INDIRECT, DISCONTINUOUS, AND POSSIBLY DISTURBED SAMPLING NECESSITATED BY USE OF SMALL-DIAMETER HOLES. ROTARY AND WASH BORING HOLES HAVE FURTHER COMPLICATIONS IN THIS REGARD BECAUSE OF THE NEED TO USE DRILLING FLUID AND/OR CASING IN ADVANCING HOLES.

THIS LOG INDICATES CONDITIONS I THIS HOLE ONLY ON THE DATE INDI CATED AND MAY NOT REPRESENT CONDI TIONS AT OTHER LOCATIONS AND O OTHER DATES. ANY WATER LEVEL SHOWN ARE SUBJECT TO VARIATION.

THIS HOLE WAS LOGGED IN SUCH A WA AS TO PROVIDE DATA PRIMARILY FO DESIGN PURPOSES AND NOT NECES SARILY FOR THE PURPOSES OF SPE CIFIC CONTRACTORS.

THE STRATIFICATION LINES OR DEP INTERVALS REPRESENT THE APPROXI MATE BOUNDARIES BETWEEN MATERI TYPES, AND THE TRANSITIONS MAY GRADUAL.

SOIL CLASSIFICATIONS SHOWN ON LO ARE FIELD CLASSIFICATIONS BASED THE UNIFIED SOILS CLASSIFICAT SYSTEM.

Wahler Associates	ANDERSON DAM SPILLWAY ENLARGEMENT	EXPLORATION BORING LOG	B
		PROJECT NO. SCV-124A	SHEET NO. 1 OF 1

UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D-2487)

PRIMARY DIVISIONS				GROUP SYMBOL	SECONDARY DIVISIONS
COARSE GRAINED SOILS MORE THAN HALF OF MATERIALS IS LARGER THAN #200 SIEVE SIZE	GRAVELS MORE THAN HALF OF COARSE FRACTION IS LARGER THAN #4 SIEVE	CLEAN GRAVELS (LESS THAN 5% FINES)		GW	WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES.
				GP	POORLY GRADED GRAVELS OR GRAVEL-SAND MIXTURES, LITTLE OR NO FINES.
		GRAVEL WITH FINES		GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURE. NON PLASTIC FINES.
				GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES. PLASTIC FINES.
	SANDS MORE THAN HALF OF COARSE FRACTION IS SMALLER THAN #4 SIEVE	CLEAN SANDS (LESS THAN 5% FINES)		SW	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES.
				SP	POORLY GRADED SANDS OR GRAVELLY SANDS, LITTLE OR NO FINES.
		SANDS WITH FINES		SM	SILTY SANDS, SAND-SILT MIXTURES. NON-PLASTIC FINES.
				SC	CLAYEY SANDS, SAND-CLAY MIXTURES. PLASTIC FINES.
FINE GRAINED SOILS MORE THAN HALF OF MATERIAL IS SMALLER THAN #200 SIEVE SIZE	SILTS & CLAYS		LIQUID LIMIT IS LESS THAN 50	ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY.
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS.
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY.
	SILTS & CLAYS		LIQUID LIMIT IS GREATER THAN 50	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS.
				CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS.
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS.
	HIGHLY ORGANIC SOILS			PT	PEAT AND OTHER HIGHLY ORGANIC SOILS.

DEFINITION OF TERMS

GRAIN SIZES

U.S. STANDARD SERIES SIEVE

200 50 16 4 3/4" 3" 6"

SILTS & CLAYS DISTINGUISHED ON BASIS OF PLASTICITY	SAND			GRAVEL		COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	COARSE		

MOISTURE CONDITION (INCREASING MOISTURE ——→)

DRY	SLIGHTLY DAMP	DAMP	(PL)	MOIST	VERY MOIST	WET (SATURATED) (LL)

KEY

SAMPLE NUMBER

SAMPLE CONTAINER:

BAG... ...... B
JAR........... J
SHELBY TUBE . S
DRIVE SAMPLER RINGS......... R

MODE

METHOD OF ADVANCING HOLE:

DRILL
- FLIGHT AUGER .... AD
- BUCKET AUGER........ BA
- SPIN AUGER.......... SD
- HOLLOW STEM AUGER... HA
- ROTARY DRILL........ RD
- CABLE TOOL.......... CT

SAMPLER
- DRIVE............... DR
- PITCHER BARREL...... PB
- CORE................ C
- PUSH................ P

RECOVERY

RECOVERY RATIO INDICATED BY A FRACTION:

$\frac{1.2}{1.5} = \frac{\text{FOOTAGE RECOVERED}}{\text{FOOTAGE SAMPLED}}$

REMARKS

INCLUDES DRILLING INFORMATION, E.G. WATER LEVEL, DATES.

REFUSAL: STOPPED BY MATERIAL TOO HARD FOR EQUIPMENT.

TERMINATED: SUFFICIENT INFORMATION OBTAINED.

ABANDONED: STOPPED BECAUSE OF DIFFICULTIES EXPLAINED ON LOG.

PENETRATION RESISTANCE (PR)

(RECORDED AS BLOWS/0.5 FOOT)

SANDS & GRAVELS

RELATIVE DENSITY	BLOWS/FOOT*
VERY LOOSE	0-4
LOOSE	4-10
MEDIUM DENSE	10-30
DENSE	30-50
VERY DENSE	OVER 50

CLAYS & SILTS

CONSISTENCY	BLOWS/FOOT*	STRENGTH †
VERY SOFT	0-2	0-¼
SOFT	2-4	¼-½
FIRM	4-8	½-1
STIFF	8-15	1-2
VERY STIFF	15-30	2-4
HARD	OVER 30	OVER 4

* Number of blows of 140 pound hammer falling 30 inches to drive a 2 inch O.D. (1-3/8 inch I.D.) Split-Barrel sampler (ASTM-1586 standard penetration test).

† Unconfined compressive strength in tons/sq ft. Read from a pocket penetrometer.

Wahler Associates

ANDERSON DAM
SPILLWAY ENLARGEMENT

KEY FOR SOIL EXPLORATION LOGS

PROJECT NO.	FIGURE NO.
SCV-124A	

KEY TO COLUMNS

SOIL CLASSIFICATION: THE UNIFIED SOIL CLASSIFICATION SYMBOL IS USED WHEN APPROPRIATE, E.G. FOR POORLY INDURATED, SEVERELY WEATHERED, OR SOIL-LIKE MATERIALS.

DESCRIPTION: INCLUDES LITHOLOGY AND PHYSICAL CONDITION OF THE ROCK. THE DESCRIPTION IS FOR PURPOSES OF IDENTIFICATION, CORRELATION, AND INTERPRETATION. THE PHYSICAL CHARACTERISTICS ARE DESCRIBED BY USING THE TERMS DEFINED BELOW.

DEPTH: DEPTH IN FEET OR METERS AS INDICATED.

SAMPLE NO: X = BOX; WC = WRAPPED CORE. DEPTH INTERVAL IS SHOWN FOR EACH BOX.

PR/RQD: ROCK QUALITY DESIGNATION (RQD). SUM OF LENGTHS OF CORE >4"/ LENGTH OF RUN; EXPRESSED AS A PERCENT. PENETRATION RESISTANCE (PR) IS NOT APPLICABLE TO ROCK LIKE MATERIALS.

REC: RECOVERY RECORDED AS A FRACTION.

MODE: METHOD OF ADVANCING HOLE: AD = AUGER DRILLING; RD = ROTARY DRILLING; C = CORING; PD = PERCUSSION DRILLING.

REMARKS: INCLUDES DRILLING INFORMATION, E.G. DRILLING NOTE, WATER LOSS, DATES, ORIENTATION AND INCLINATION OF HOLE IF ANGLE HOLE.

DEFINITION OF TERMS

HARDNESS

VERY SOFT:	EASILY CRUMBLED OR DEFORMED BY HAND.
SOFT:	MAY BE BROKEN USING BOTH HANDS, OR IF PLASTIC, DEFORMED BY HAND. MAY BE CUT WITH DIFFICULTY WITH KNIFE. EASILY POWDERED WITH PICK, DULL THUD WHEN STRUCK WITH HAMMER.
MODERATELY HARD:	MAY BE SCRATCHED WITH KNIFE, TO SHALLOW DEPTH DULL RING WHEN STRUCK WITH HAMMER.
VERY HARD:	CANNOT BE SCRATCHED WITH KNIFE. SHARP RING WHEN STRUCK.

STRENGTH

PLASTIC:	CAN BE DEFORMED BY HAND
FRIABLE:	CRUMBLES BY RUBBING WITH FINGERS
WEAK:	AN UNFRACTURED OUTCROP OF SUCH MATERIAL WOULD CRUMBLE UNDER LIGHT HAMMER BLOWS
MODERATELY STRONG:	OUTCROP WOULD WITHSTAND A FEW FIRM BLOWS BEFORE BREAKING.
STRONG:	OUTCROP WOULD WITHSTAND A FEW HEAVY RINGING HAMMER BLOWS BUT WILL YIELD LARGE FRAGMENTS.
VERY STRONG:	OUTCROP WOULD RESIST HEAVY RINGING HAMMER BLOWS AND WILL YIELD WITH DIFFICULTY ONLY DUST AND SMALL FRAGMENTS.

WEATHERING

EXTENT	DECOMPOSITION	DISINTEGRATION	DISCOLORATION	FRACTURE CONDITION
SEVERE	MODERATE TO COMPLETE ALTERATION OF MINERALS, FELDSPARS ALTERED TO CLAY, ETC.	GENERALLY FRIABLE, BUT ROCK TEXTURE AND STRUCTURE ARE PRESERVED.	EXTENSIVE AND THOROUGH	ALL FRACTURES EXTENSIVELY COATED WITH OXIDES CARBONATES, OR CLAY
MODERATE	SLIGHT ALTERATION OF MINERALS, CLEAVAGE SURFACES LUSTERLESS AND STAINED	MOST CEMENTATION IS AFFECTED; MAY BE LOCALLY FRIABLE.	MODERATE OR LOCALIZED AND INTENSE	THIN COATINGS OR STAINS
SLIGHT	NO MEGASCOPIC ALTERATION OF MINERALS	LITTLE TO NO EFFECT ON NORMAL CEMENTATION.	SLIGHT AND INTERMITTENT AND LOCALIZED	FEW STAINS ON FRACTURE SURFACES.
FRESH	UNALTERED, CLEAVAGE SURFACE GLISTENING.	CEMENTATION UNAFFECTED	NO DISCOLORATION	NO STAINS

FRACTURING*

EXTENT	ENGLISH SIZE RANGE	METRIC SIZE RANGE
CRUSHED (MAY CONTAIN CLAY)	LESS THAN 0.05'	LESS THAN 1.5 cm.
INTENSELY FRACTURED	0.05' TO 0.1'	1.5 cm. TO 3 cm.
CLOSELY FRACTURED	0.1' TO 0.5'	3 cm. TO 15 cm.
MODERATELY FRACTURED	0.5' TO 1.0'	15 cm. TO 30 cm
LITTLE FRACTURED	1.0' TO 3.0'	30 cm. TO 100 cm.
MASSIVE	3.0' AND LARGER	1 m. AND LARGER

FRACTURE COATINGS

EXTENT	THICKNESS
UNSTAINED OR CLEAN: NEARLY ALL SURFACE CLEAN	STAINED: NO PERCEPTIBLE THICKNESS
SMALL: COVERS LESS THAN 10% OF FRACTURE SURFACE	THIN: BARELY PERCEPTIBLE
MODERATE OR PATCHY: COVERS 10% TO 50% OF SURFACE	MEDIUM: UP TO 2 mm
EXTENSIVE: COVERS MORE THAN 50% OF SURFACE	THICK: OVER 2 mm

STRATIFICATION

STRATIFICATION (OR PARTING)	CROSS-STRATIFICATION	APPROXIMATE THICKNESS**	
		ENGLISH	METRIC
VERY THICK-BEDDED (-PARTED)	VERY THICKLY CROSS-BEDDED	OVER 3 ft.	OVER 1 m
THICK-BEDDED (-PARTED)	THICKLY CROSS-BEDDED	1-3 ft.	30-100 cm.
MEDIUM-BEDDED (-PARTED)	MEDIUM CROSS-BEDDED	4-12 in	10-30 cm
THIN-BEDDED (-PARTED)	THINLY CROSS-BEDDED	1-4 in.	3-10 cm
VERY THIN-BEDDED (-PARTED)	VERY THINLY CROSS-BEDDED	0.5-1 in.	1-3 cm.
LAMINATED (THINLY PARTED)	CROSS-LAMINATED	0.1-0.5 in.	0.3-1.0 cm.
THINLY LAMINATED (VERY THINLY PARTED)	THINLY CROSS-LAMINATED	LESS THAN 0.1 in.	LESS THAN 0.3 cm.

* JOINTS AND FRACTURES ARE TREATED THE SAME FOR THE PHYSICAL DESCRIPTION AND BOTH ARE REFERRED TO AS FRACTURES; SIZE RANGE REFERS TO SIZE OF PIECES.

** MASSIVE IF BEDS ARE OVER 10 ft. (3 m.) THICK.

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PROJECT NO.	FIGURE NO.	
SCV-124A		KEY FOR ROCK CORE LOGS

APPENDIX B

APPENDIX B

LABORATORY INVESTIGATION

A. INTRODUCTION

This appendix includes a discussion of test procedures and results of the laboratory investigation performed by Wahler Associates for the Anderson Spillway Modifications. The investigation program was carried out employing, in most cases, currently accepted test procedures of the American Society of Testing and Materials (ASTM).

Undisturbed thin-wall tube samples and bulk plastic bag samples used in the laboratory investigation were obtained during the course of the field investigation as described in Appendix A of this report. Identification of each sample is by hole number, sample number, and depth.

B. INDEX PROPERTIES TESTING

In the field of soil mechanics and earth dam design, it is advantageous to have a standard method of identifying soils and classifying them into categories or groups that have similar or distinct engineering properties. The most commonly used method of identifying and classifying soils according to their engineering properties is the Unified Soil Classification System (USCS), as described by ASTM D2487-69. The USCS is based on a recognition of the various types and significant distribution of soil characteristics, and plasticity of materials.

The index properties tests discussed in this report include the determination of natural water content and in-place dry density, grain-size distribution, Atterberg limits, and specific gravity.

1. Natural Water Content and Dry Density

Natural water content and dry density were determined, usually in conjunction with other tests, on selected undisturbed tube samples. The samples were extruded and visually classified, trimmed to obtain a smooth flat face, and accurately measured to obtain volume and wet weight. The samples were then dried, in accordance with ASTM 2216-71, for a period of 24 hours in an oven maintained at a temperature of 110°C. After drying, the weight of each sample was determined and the moisture content and dry density calculated. The bulk plastic bag samples were tested for water content only. All the water content and dry density results are summarized in Table B-1 and are also shown with the various other index and engineering properties test results.

2. Grain-Size Distribution

The gradation characteristics of selected samples were determined in accordance with ASTM D422-63 and USBR E-6, except as modified below. The gravelly samples were initially sieved through the 3/4-inch and 1-1/2-inch sieves. Representative samples were obtained and soaked in water until individual soil particles were separated and then washed on the No. 200 mesh sieve. That portion of the material retained on the No. 200 mesh sieve was oven-dried and then mechanically sieved. A hydrometer analysis was performed on a representative portion of the minus No. 200 mesh material of selected samples. The hydrometer test was run in a constant-temperature hydrometer bath using sodium hexametaphosphate as a dispersing agent. The grain-size distribution tests are presented on Figures B-1 through B-12. In addition, three selected samples were tested for percent passing #200 and .002 mm. These results appear in Table B-2.

3. Atterberg Limits

Liquid and plastic limits were determined on selected samples in accordance with ASTM Designation D423-66 and D424-59. Results of the Atterberg limits tests are summarized on Figures B-13 through B-19. The swell potential of three selected samples from behind the existing right chute wall, is shown on Figure B-20.

4. Specific Gravity

Specific gravity determinations were made on selected samples in accordance with the procedure given in Soil Testing for Engineers by T. William Lambe. The specific gravity test results are shown in Table B-3.

C. ENGINEERING PROPERTIES TESTING

The engineering properties testing consisted of compaction, consolidation, unconfined compression, direct shear, swell tests and triaxial shear.

1. Compaction Testing

Compaction tests were performed to determine the moisture-density relationship of the selected samples. The tests were performed in accordance with ASTM Designation D1557-78, Method A or C (4-inch mold or 6-inch mold), modified to yield 20,000 foot-pounds per cubic foot (ft-lb/ft^3) by reducing the number of layers to three and the number of blows per layer to 15 for Method A and 34 for Method C. The compaction results, together with average gradation characteristics of the materials tested are presented on Figures B-21 through B-24.

2. Consolidation Tests

One-dimensional consolidation tests were performed on selected undisturbed samples in accordance with ASTM D2435-70, except as modified below. After trimming, the samples were extruded directly into the consolidation rings. The samples were placed in a consolidometer and loaded to 125, 250, and 500 psf. After they had consolidated under 500 psf, the samples were flooded with water and observed. The samples were then loaded to 2,000, 4,000 and 8,000 psf. After 8,000 psf, the samples were rebounded, reloaded, and then the loading sequence was continued to 16,000 and 32,000 psf. The samples were allowed to consolidate for approximately 24 hours under each load increment. Loads were applied to the samples by the use of air pressure regulators feeding into the consolidometer. Accuracy was maintained throughout the loading range by the use of sensitive oil and mercury manometers for the lower loads and psi gauges for the higher loads. Sample deformation was measured to 0.0001 inch. Rebounding was done at twice the rate of loading and the final specimen data were calculated at the last rebound increment. Results of the consolidation tests, in the form of percent consolidation versus log of pressure, are presented on Figures B-25 through B-27.

3. Unconfined Compression Tests

Selected samples were tested for unconfined compressive strength in accordance with ASTM D2166-66. Unconfined compressive strength versus axial strain was monitored during the test. The results appear on Table B-4. A stress/strain plot of one of the tests appears on Figure B-28.

4. Direct Shear Tests

Direct shear tests were performed on selected undisturbed samples. After the initial weight and volume measurements were determined, each sample was placed in the shear machine. The designated normal load was applied and the sample was flooded with water and allowed to consolidate. The sample was then sheared horizontally at a rate of strain of 0.025 inches per minute. Shear stress and sample deformation were monitored throughout the test. The results of the direct shear test appear on Figures B-29 through B-32.

5. Swell Tests

Selected undisturbed samples were tested for swell potential. The samples were set-up and placed in a consolidometer as described in Consolidation

Tests above. The samples were then consolidated to 500 psf and flooded with water. After flooding, a sufficient load was incrementally applied in order to prevent the samples from swelling. After soaking overnight, the samples were unloaded and any swell was measured. The results of the swell tests appear on Figures B-33 through B-35.

6. Triaxial Shear Testing

a. Sample Preparation - Samples selected for testing were extruded from the tubes using a hydraulically operated ram capable of exerting the minimum force necessary to free the sample from the tube. The samples were then trimmed to an approximate 2:1 height to diameter ratio. With the aid of a special trimming device which completely supported the sample, the possibility of sample disturbance due to handling was significantly reduced.

After the initial weight and volume measurements were determined, each specimen was placed in a triaxial cell, encased in a rubber membrane and sealed to the bottom pedestal and top cap with rubber "O" rings. After securing the triaxial chamber, the cell was filled with water and fitted with a 1-inch-diameter stainless steel piston for load application and transported to the saturation bay.

b. Sample Saturation and Consolidation - The laboratory is equipped with a panel of nine bays, with individual pressure control to each bay, such that nine triaxial samples can be simultaneously saturated and/or consolidated at different individual pressures. Bleeding air regulators capable of delivering air pressure up to 150 psi are used to control the top, bottom, and chamber lines leading to the triaxial cells. Each saturation bay is also equipped with constant diameter Pyrex sight tubes, each with a cross-sectional area of 0.075 square inch, which connect with the base of the triaxial cell, and thus to the sample. The sight tubes are easily read to the nearest 0.01 cubic inch.

The samples were saturated using a combination vacuum-back pressure technique. A small vacuum was applied to increase the initial saturation without a change in void ratio. A back pressure of 50 psi was then incrementally applied to obtain a sufficient degree of saturation prior to the consolidation phase of the test. In order to determine whether the back pressure applied was causing complete saturation, Skempton's "B" parameter was measured for all samples. A value in excess of 0.95 was considered to represent a fully saturated condition. After achieving complete saturation, the chamber pressure was increased above the back pressure to the designated consolidation pressure. The top and bottom drainage lines were then simultaneously opened, and the total volume of water expelled from the sample was monitored as a function of time. Strips of filter paper placed inside the membrane along the sides of the samples accelerated the consolidation process.

c. Sample Failure - The triaxial specimens were failed by compression loading at a constant rate of strain while maintaining a constant minor principal stress. The rate of strain selected for sample failure was dependent upon the materials' consolidation characteristics. Load readings were recorded during the tests at specified axial deformations using a BLH (0-2,000) load cell. Pore pressure measurements were obtained by a Stathom pore pressure transducer (0-200 psi). The adopted failure criterion used for the presentation of the Mohr circle of stress was the point of maximum principal effective stress ratio. Results of the triaxial shear tests appear on Figures B-36 through B-39.

TABLE B-1

NATURAL WATER CONTENT AND DRY DENSITY

Hole No.	Sample No.	Depth (ft.)	Water Content	Dry Density
AD-1	S-3	12.5-15.0	37.4	80.7
	S-3	12.5-15.0	20.1	107.8
	S-4	17.5-20.0	33.9	83.0
	S-5	20.5-23.0	30.3	86.9
	S-5	20.5-23.0	30.2	88.0
	S-7	25.0-27.6	35.9	80.3
	S-9	30.0-32.5	26.3	92.5
	S-11	35.0-37.5	27.3	90.9
	S-11	35.0-37.5	27.7	93.3
	S-12	37.5-40.0	27.3	94.8
	S-12	37.5-40.0	23.4	98.4
AD-2	S-1	3.0- 5.5	22.4	98.3
	S-1	3.0- 5.5	22.9	97.0
	R-2	27.5-29.0	26.1	91.8
	R-2	27.5-29.0	26.0	93.7
	R-2	27.5-29.0	27.2	93.7
AD-3	R-1	3.5- 5.0	31.1	89.0
	R-2	8.5-10.0	40.4	80.2
	R-3	18.5-20.0	37.2	80.7
	S-1	12.0-15.0	32.4	84.5
	S-1	12.0-15.0	44.6	75.7
AD-4	R-1	3.5- 5.0	14.3	118.9
	R-1	3.5- 5.0	15.6	116.3
	S-1	7.5-10.0	19.5	109.7
	R-2	13.0-14.5	17.8	111.7
AD-5	R-1	3.0- 4.5	16.9	108.5
	S-1	8.5-11.0	52.7	68.6
	R-2	13.0-14.5	19.5	108.7
	R-2	13.0-14.5	18.5	112.4
AD-6	S-1	10.0-12.3	18.7	109.8
	S-1	10.0-12.3	21.1	106.5
AD-8	S-1	13.0-15.5	25.9	97.3
	S-1	13.0-15.5	26.4	95.1
AD-10	B-3	5.0- 6.5	13.8	--
AD-11	B-1	2.0- 3.5	13.6	--
AD-12	B-4	5.2- 6.7	14.6	--

TABLE B-1 (Continued)

NATURAL WATER CONTENT AND DRY DENSITY

Hole No.	Sample No.	Depth (ft.)	Water Content	Dry Density
AD-13	B-1	1.5- 2.0	6.4	--
	B-3	3.3- 4.8	18.2	--
TD-2	B-1	1.0- 2.0	17.8	--
	B-2	3.0- 4.5	15.4	--
	B-3	4.5- 6.0	10.4	--
TP-3	B-1	1.5- 5.5	30.7	--
	B-2	5.5- 9.0	28.2	--
	B-3	10.0-12.5	32.6	--
TP-5	B-1	1.0- 3.5	24.2	--
	B-2	5.0- 9.0	36.1	--
	B-3	10.0-11.0	36.6	--
TP-6	B-1	1.0- 2.5	30.3	--
	B-2	3.5- 6.5	44.1	--
	B-3	8.0-10.0	44.5	--
TP-7	B-1	7.5-10.0	16.0	--
TP-9	B-1	3.0- 6.0	16.1	--
	B-2	7.5-11.0	18.6	--
TP-11	B-1	1.0- 2.0	19.5	--
	B-2	2.0- 3.5	8.8	--
TP-14	B-1	2.0- 5.5	15.1	--
	B-2	6.0- 9.0	28.7	--
	B-3	9.0-11.5	26.8	--
TP-15	B-1	2.0- 4.0	43.8	--
	B-2	4.0- 8.0	21.4	--
T-11	B-2	0- 4.0	13.8	--
	B-1	4.0- 8.0	30.5	--

TABLE B-2

PERCENT PASSING #200 and .002 mm

Drill Hole No.	Sample No.	Depth, ft.	Percent Passing #200	Percent Passing .002 mm
DH-7-1	B-1	1.20-2.35	44.5	9.5
DH-7-2	B-1	1.35-1.55	25.5	5.1
DH-7-3	B-2	1.50-1.90	39.9	8.3

TABLE B-3

SPECIFIC GRAVITY

Hole No.	Sample No.	Depth, ft.	Specific Gravity
TP-2	B-1	1.0- 2.0	2.67
	B-2	3.0- 4.5	2.69
TP-5	B-3	10.0-11.5	2.79
TP-9	B-1	3.0- 6.0	2.68
	B-2	7.5-11.0	2.71
TP-14	B-1	2.0- 5.5	2.63

TABLE B-4

UNCONFINED COMPRESSIVE STRENGTH

Hole No.	Sample No.	Depth, ft.	Unconfined Compressive Strength, (psf.) Peak or 10% Strain
AD-3	R-1	3.5- 5.0	4369
	R-2	8.5-10.0	2163
AD-4	R-1	3.5- 5.0	7463
	S-1	7.5-10.0	1115
AD-5	S-1	8.5-11.0	2354*

*See Figure B.28 for stress/strain plot

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ANDERSON DAM
SPILLWAY ENLARGEMENT

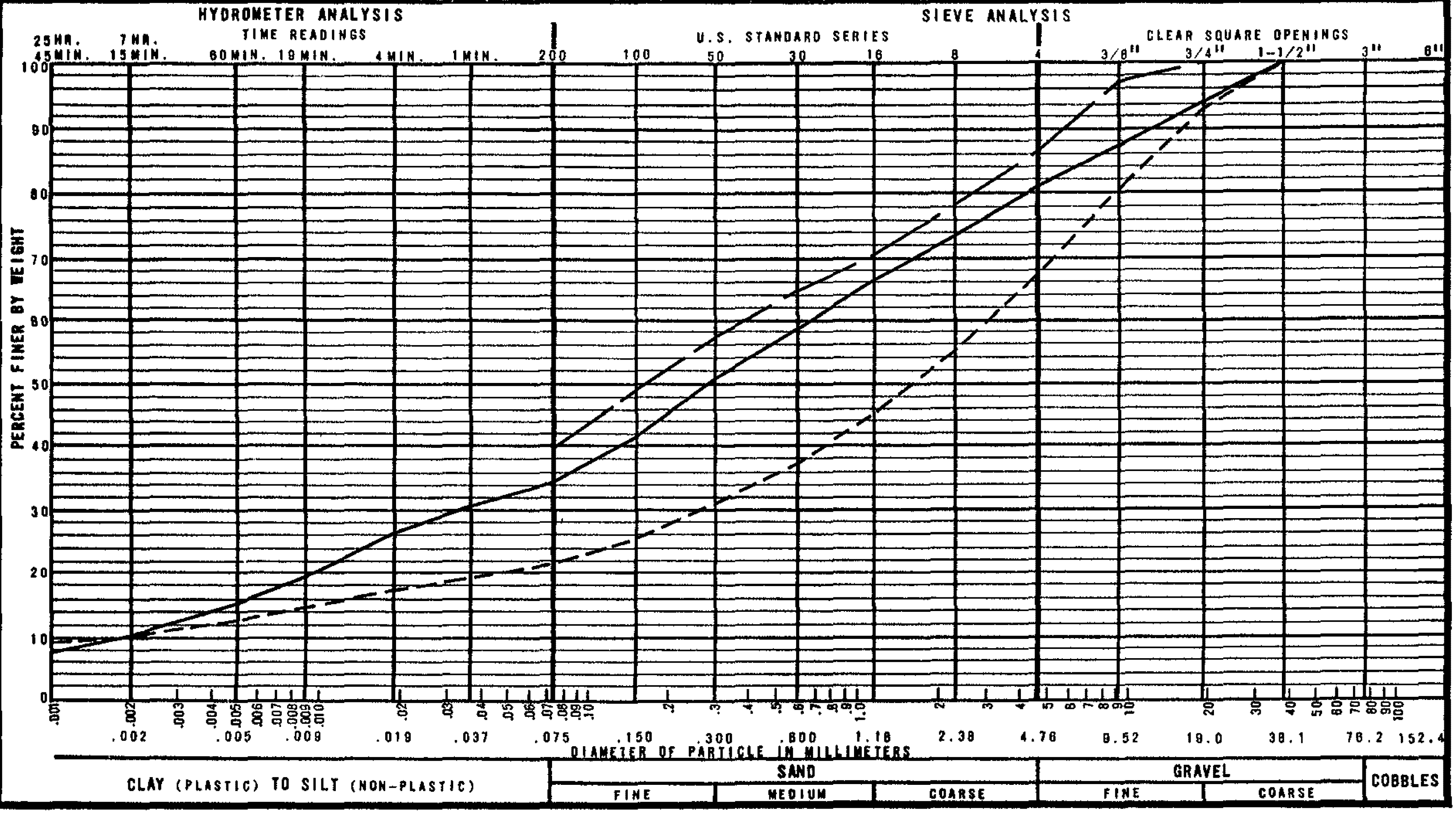
GRADATION TEST RESULTS

PROJECT NO. SCV-124A

DATE SEPTEMBER 1983

FIGURE NO. B-

KEY:	———	— — —	- - -						
LL	64	----	----						
PL	39	----	----						
PI	25	----	----						
NAT. W/C	37.4	30.6	23.4						
SPEC. GRAVITY	----	----	----						
CLASSIF. SYMB.	SM	SC	SM						
SAMPLE NO.	S-3	S-7	S-12						
DEPTH, FT.	12.5-15.0	25.0-27.5	37.5-40.0						
HOLE NO.	AD-1	AD-1	AD-1						



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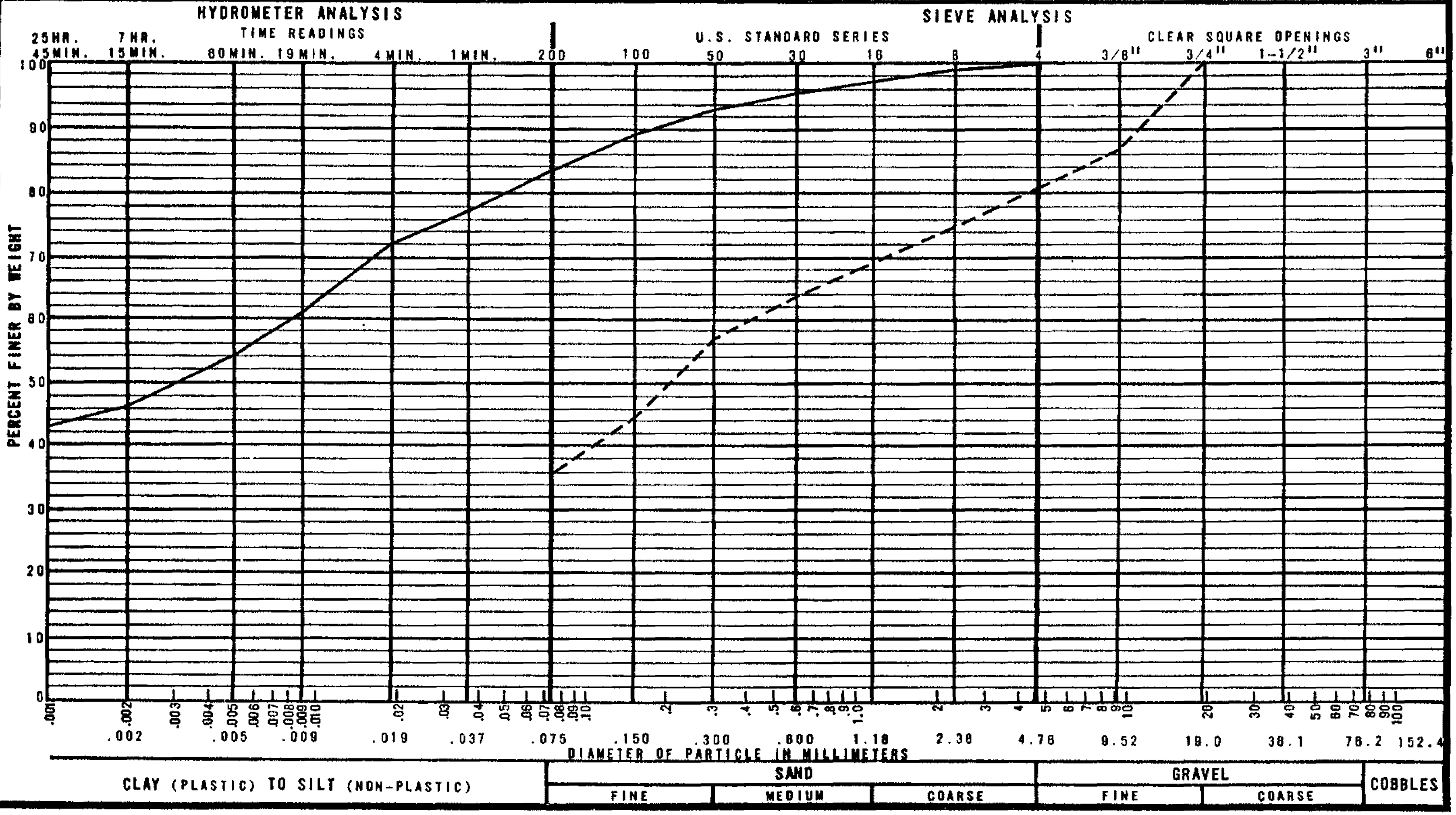
GRADATION TEST RESULTS

PROJECT NO. SCV-124A

DATE SEPTEMBER 1983

FIGURE NO. B-2

KEY:	———	– – – –							
LL	----	----							
PL	----	----							
PI	----	----							
NAT. W/C	21.1	25.9							
SPEC. GRAVITY	----	----							
CLASSIF.SYMB.	CL	SM							
SAMPLE NO.	S-1	S-1							
DEPTH, FT.	10.0-12.3	13.0-15.5							
HOLE NO.	AD-6	AD-8							



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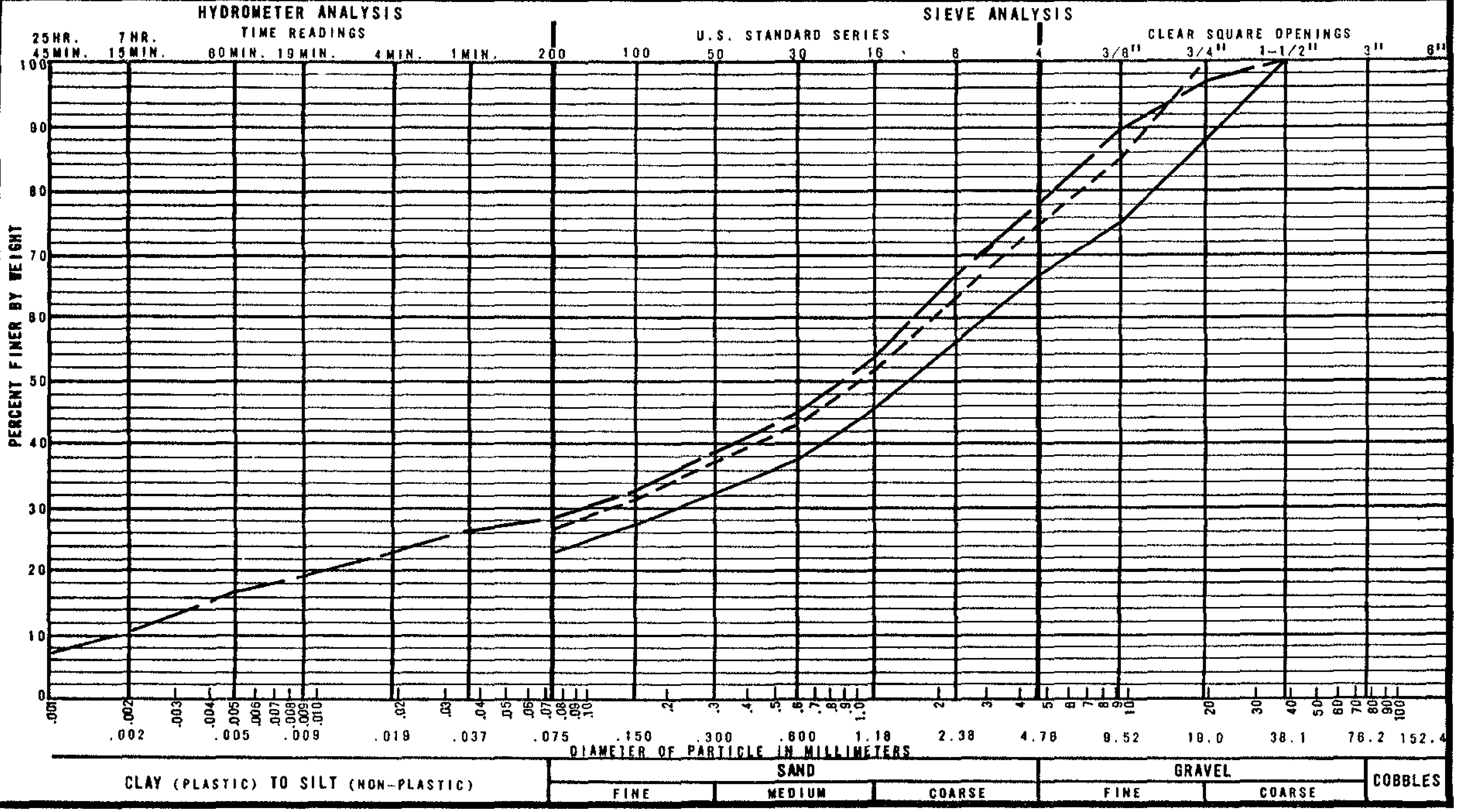
GRADATION TEST RESULTS

PROJECT NO. SCV-124A

DATE OCTOBER 1983

FIGURE NO. B-3

KEY:	———	- - -	— — —						
LL	44	44	47						
PL	24	25	22						
PI	20	19	25						
NAT. W/C	13.8	13.6	14.6						
SPEC. GRAVITY	----	----	----						
CLASSIF.SYMB.	SC	SC-SM	SC						
SAMPLE NO.	B-3	B-1	B-4						
DEPTH, FT.	5.0-6.5	2.0-3.5	5.2-6.7						
HOLE NO.	AD-10	AD-11	AD-12						



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SPILLWAY ENLARGEMENT

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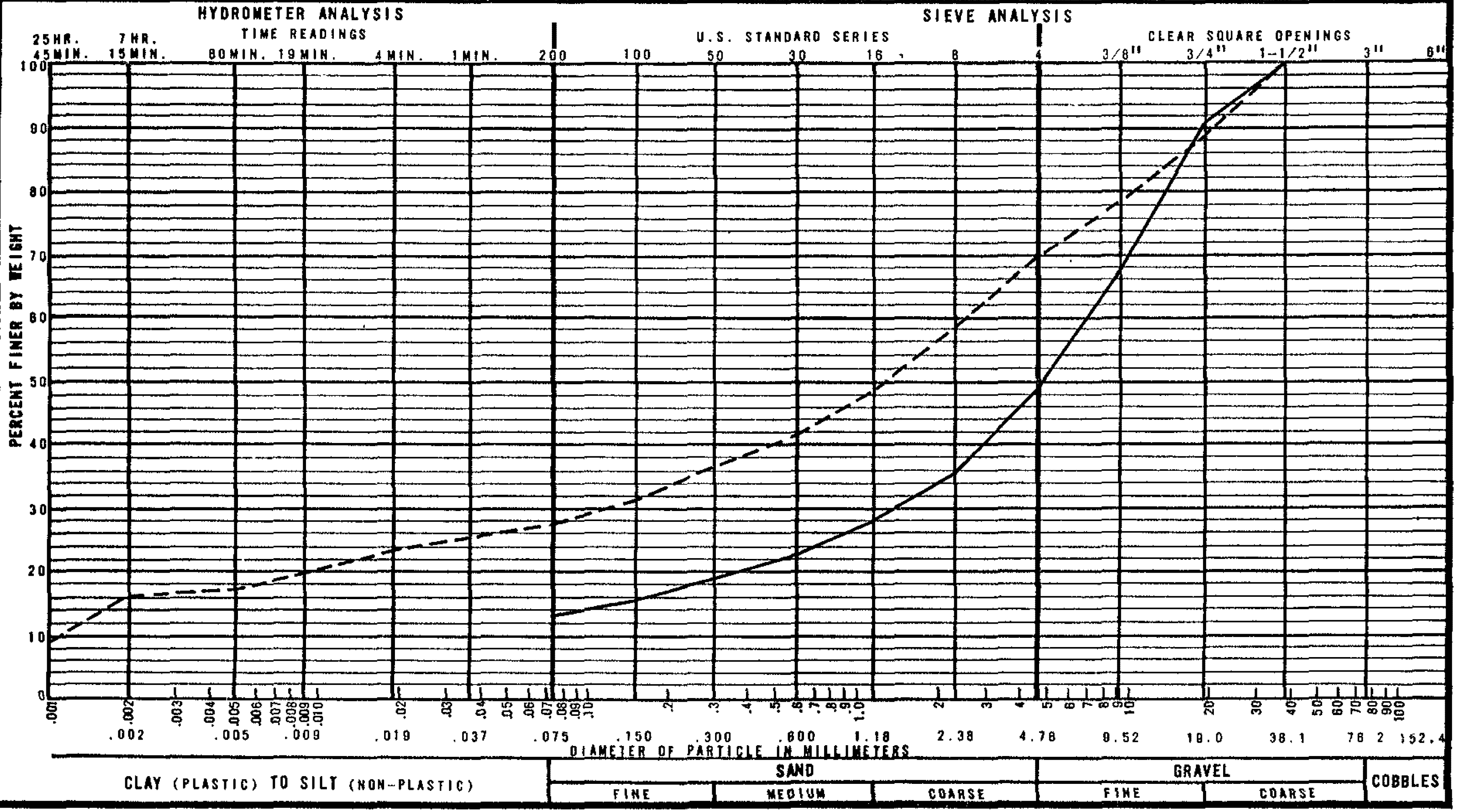
GRADATION TEST RESULTS

PROJECT NO. SCV-124A

DATE OCTOBER 1983

FIGURE NO. B-4

KEY:	————	– – – –							
LL	36	53							
PL	18	25							
PI	18	28							
NAT. W/C	6.4	18.2							
SPEC. GRAVITY	----	----							
CLASSIF.SYMB.	GC	SC							
SAMPLE NO.	B-1	B-3							
DEPTH, FT.	1.5-2.0	3.3-4.8							
HOLE NO.	AD-13	AD-13							



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SPILLWAY EMLARGEMENT

GRADATION TEST RESULTS

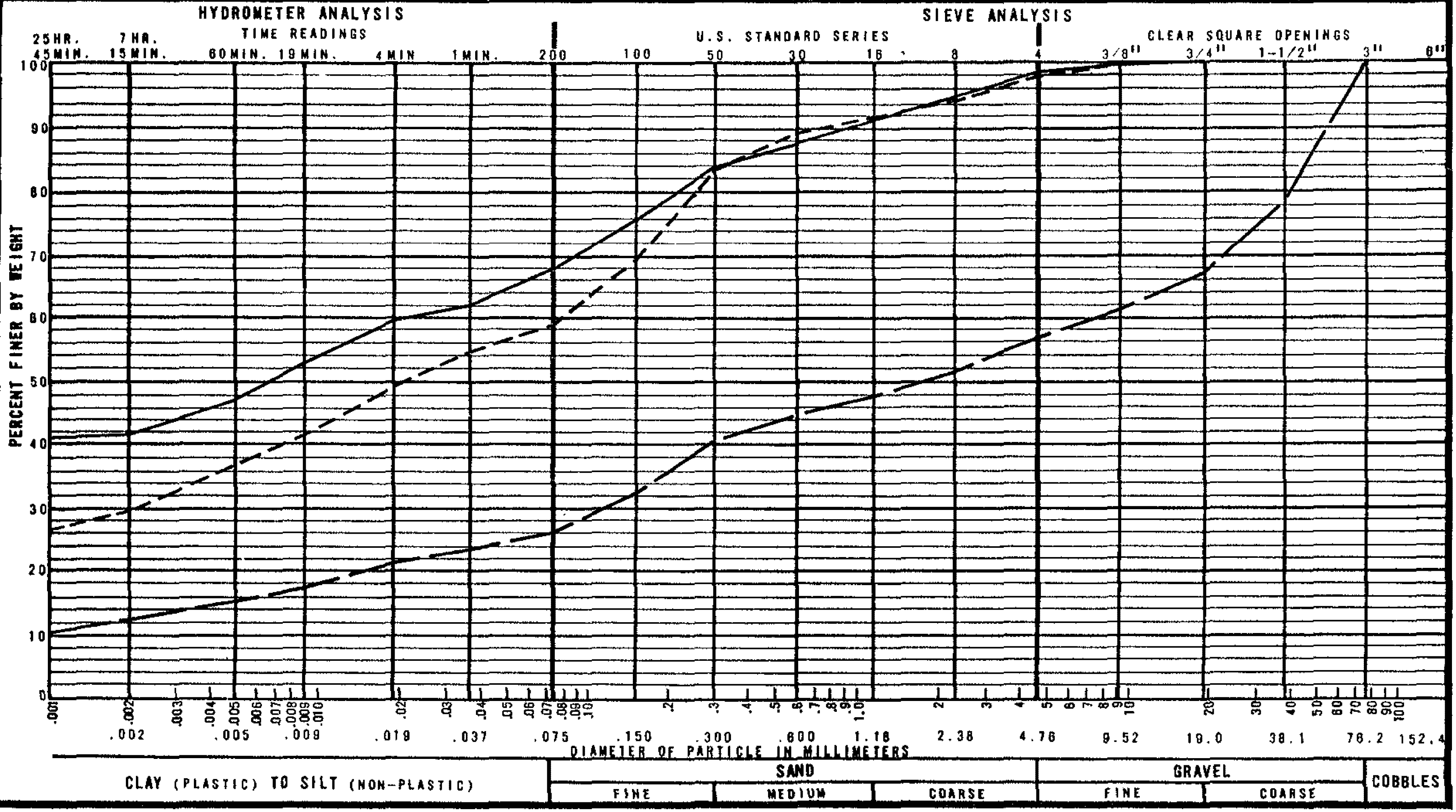
PROJECT NO. SCV-124A

DATE JULY 1983

FIGURE NO. B-5

*SAMPLE APPEARS COARSER, BUT BREAKS DOWN DURING TESTING

KEY:	————	– – – –	—— ——						
LL	53	38	36						
PL	20	15	18						
PI	33	23	18						
NAT. W/C	17.8	15.4	10.4						
SPEC. GRAVITY	2.67	2.69	----						
CLASSIF.SYMB.	CH	CL	GC						
SAMPLE NO.	B-1	B-2	B-3*						
DEPTH, FT.	1.0-2.0	3.0-4.5	4.5-6.0						
HOLE NO.	TP-2	TP-2	TP-2						



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SPILLWAY ENLARGEMENT

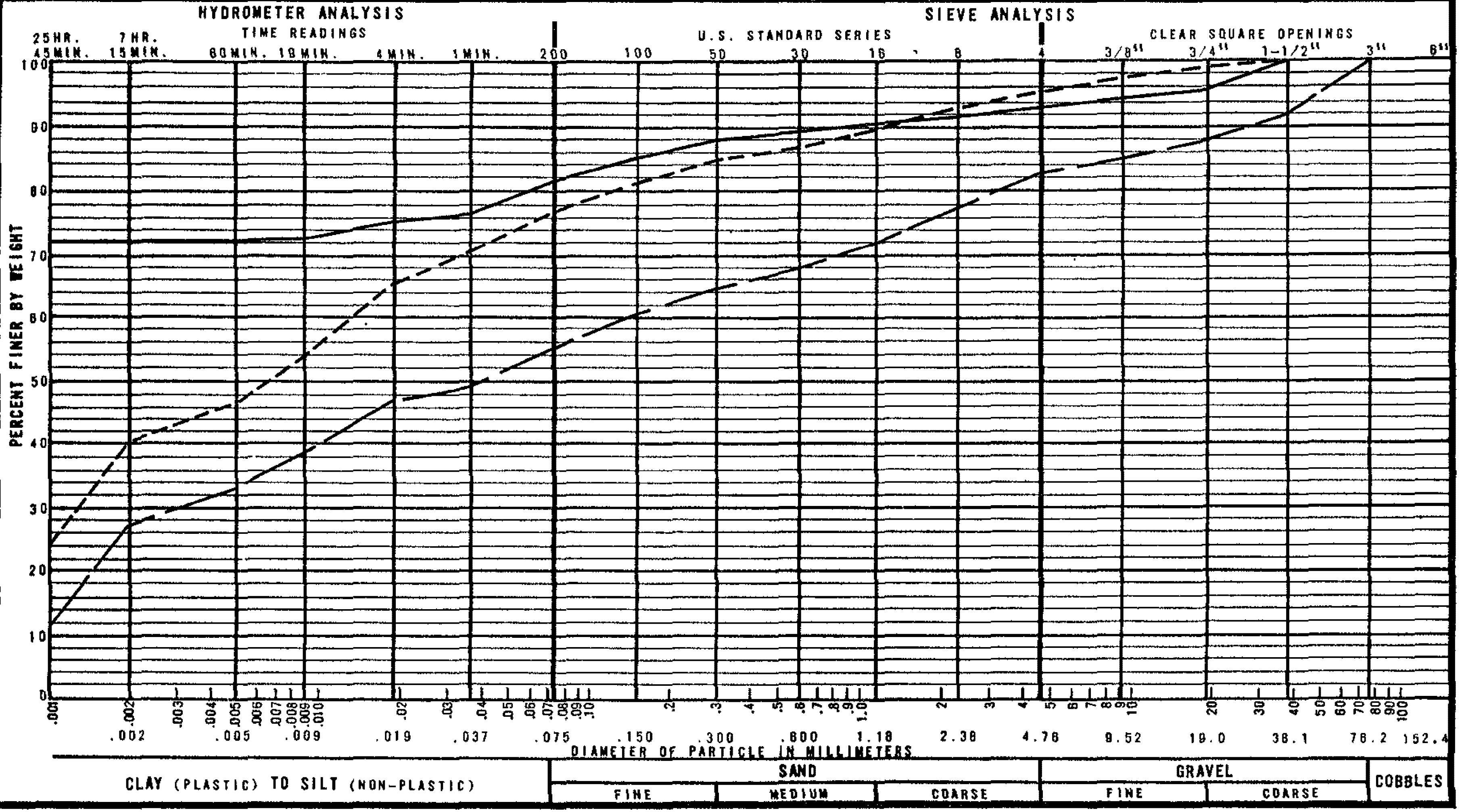
GRADATION TEST RESULTS

PROJECT NO. SCV-124A

DATE JULY 1983

FIGURE NO. B-6

KEY:	———	– – – –	— — —						
LL	73	66	83						
PL	26	27	34						
PI	47	39	49						
NAT. W/C	30.7	28.2	32.6						
SPEC. GRAVITY	----	----	----						
CLASSIF.SYMB.	CH	CH	CH						
SAMPLE NO.	B-1	B-2	B-3						
DEPTH, FT.	1.5-5.5	5.5-9.0	10.0-12.5						
HOLE NO.	TP-3	TP-3	TP-3						



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SPILLWAY ENLARGEMENT

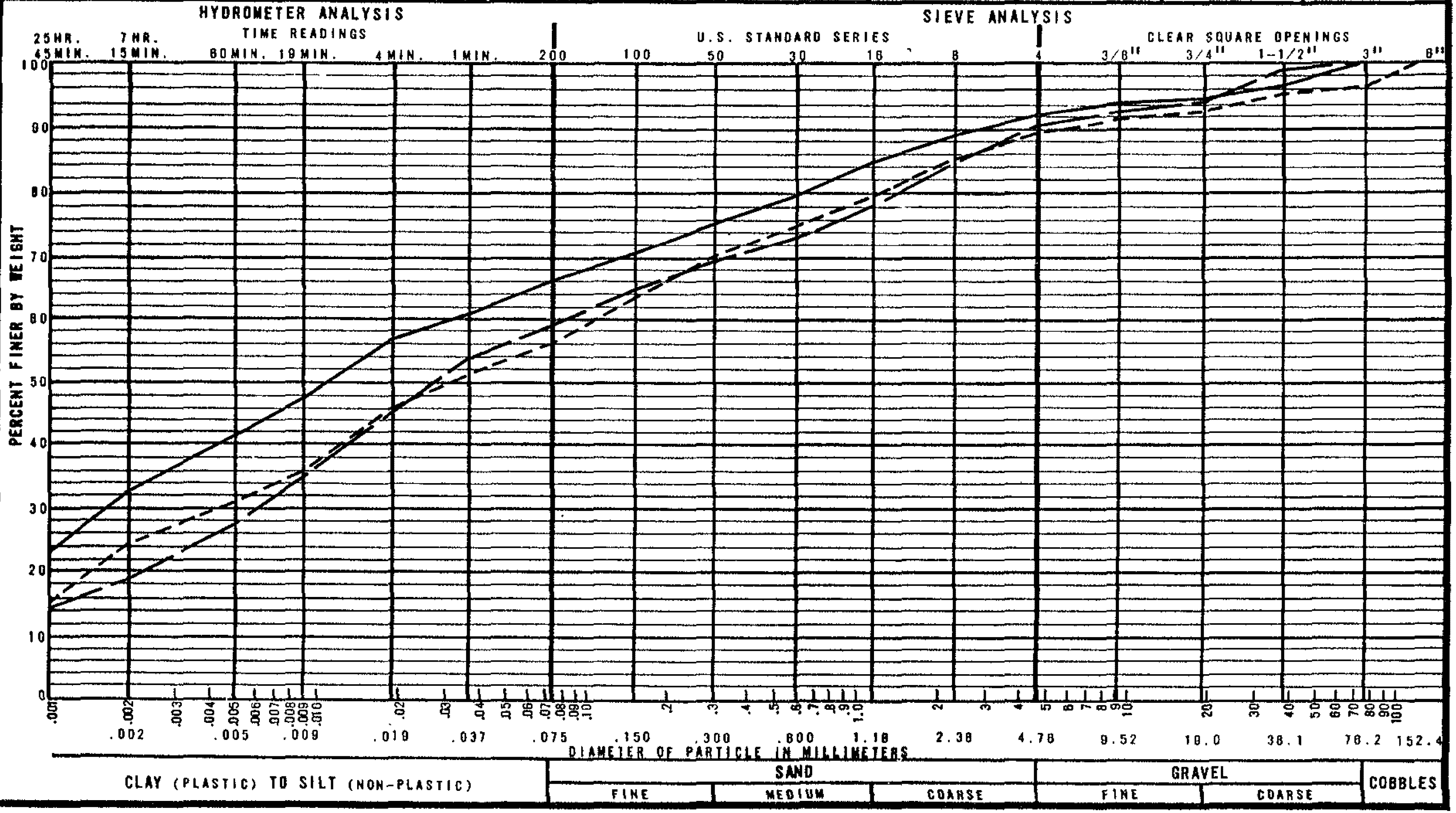
GRADATION TEST RESULTS

PROJECT NO. SCV-124A

DATE JULY 1983

FIGURE NO. B-

KEY:	———	— — —	- - -					
LL	68	88	79					
PL	29	38	38					
PI	39	50	41					
NAT. W/C	24.2	36.1	36.6					
SPEC. GRAVITY	-----	-----	2.79					
CLASSIF.SYMB.	CH	CH-MH	MH					
SAMPLE NO.	B-1	B-2	B-3					
DEPTH, FT.	1.0-3.5	5.0-9.0	10.0-12.5					
HOLE NO.	TP-5	TP-5	TP-5					



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ANDERSON DAM
SPILLWAY ENLARGEMENT

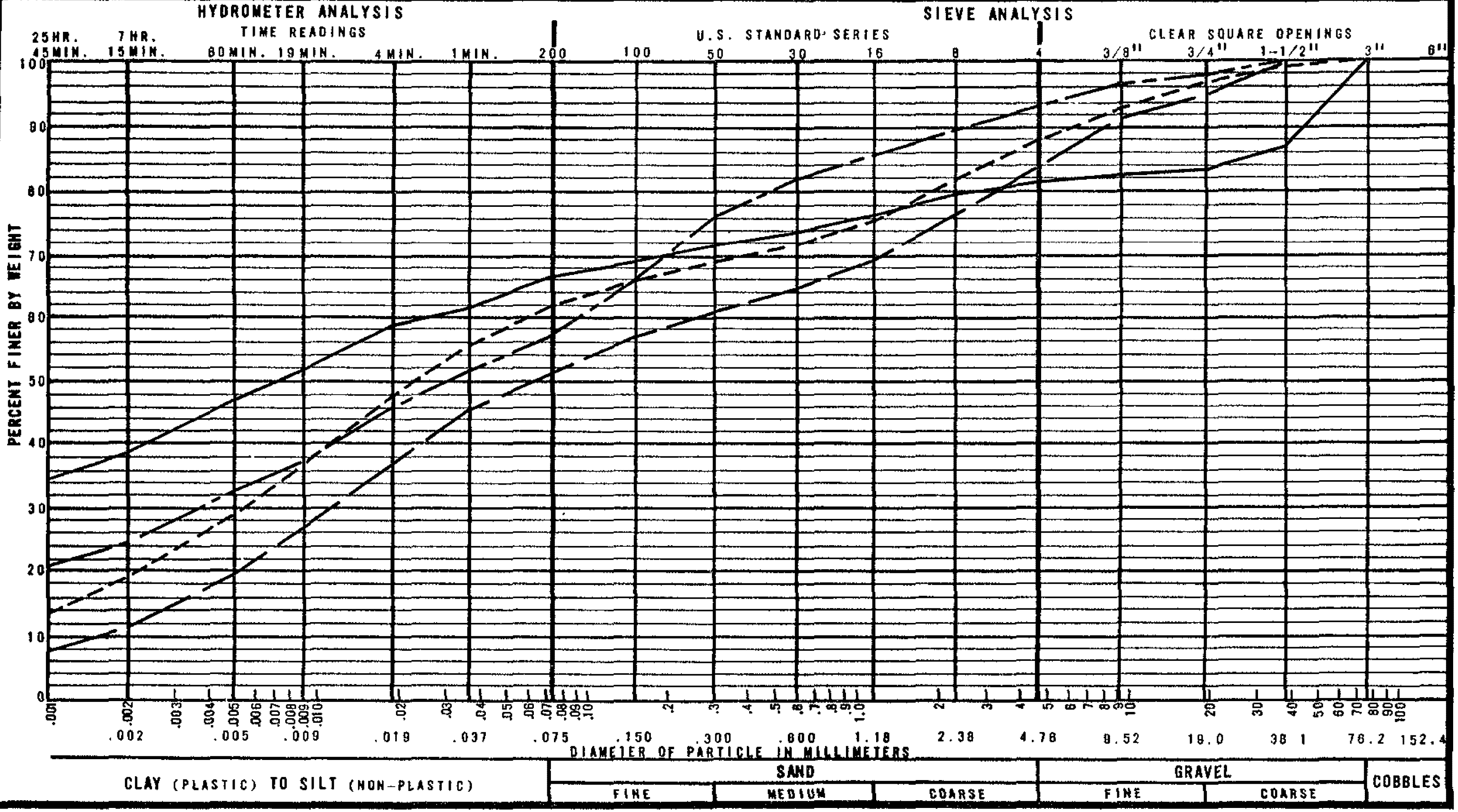
GRADATION TEST RESULTS

PROJECT NO. SCV-124A

DATE AUGUST 1983

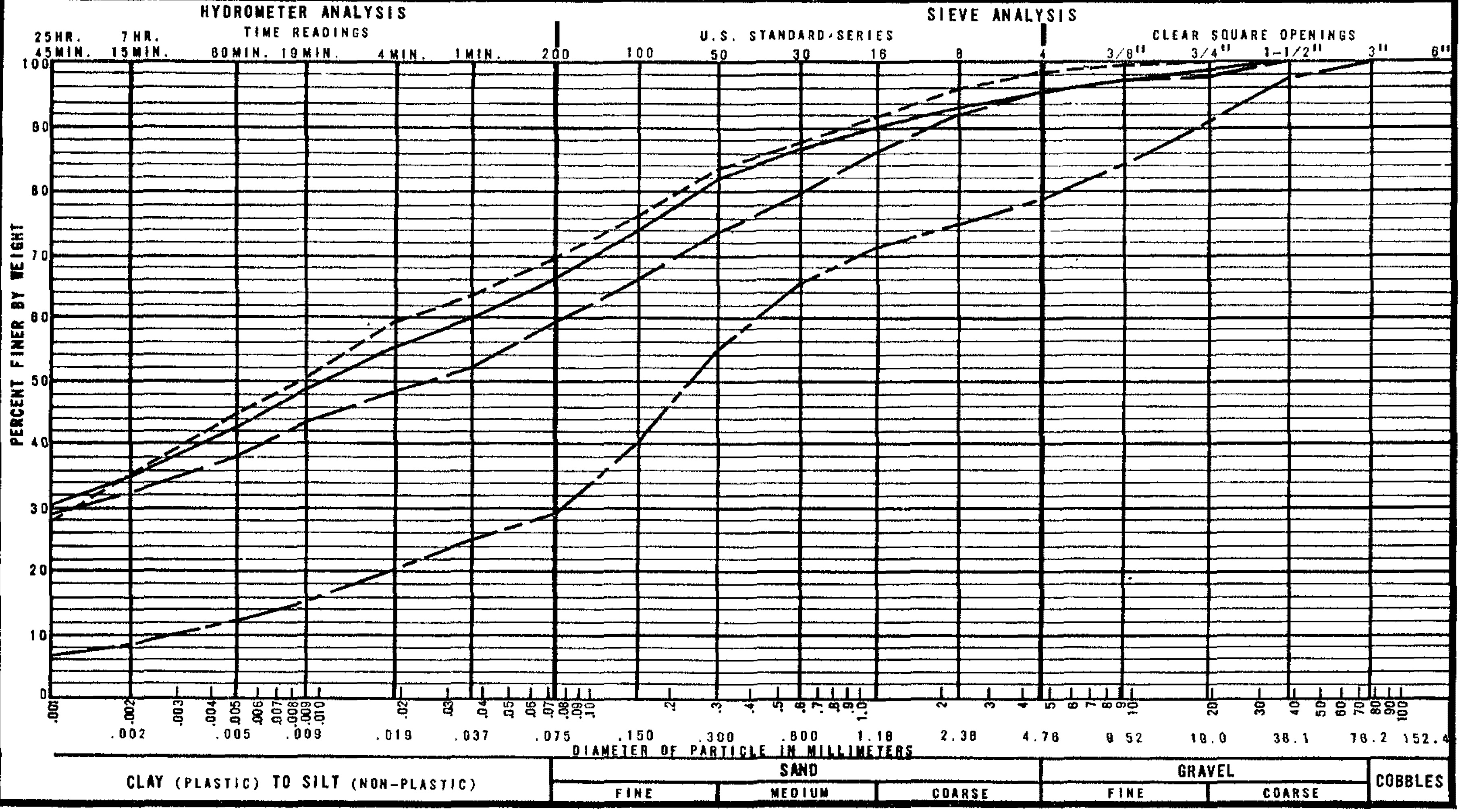
FIGURE NO. B-8

KEY:	———	- - - -	—— ——	—— — ——					
LL	81	94	70	38					
PL	34	46	50	17					
PI	47	48	20	21					
NAT. W/C	30.3	44.1	44.5	16.0					
SPEC. GRAVITY	----	----	----	----					
CLASSIF.SYMB.	CH	MH	MH	CL					
SAMPLE NO.	B-1	B-2	B-3	B-1					
DEPTH, FT.	1.0-2.5	3.5-6.5	8.0-10.0	7.5-10.0					
HOLE NO.	TP-6	TP-6	TP-6	TP-7					



*SAMPLE APPEARS COARSER, BUT BREAKS DOWN DURING TEST

KEY:	————	— — —	— - — -	— — — —					
LL	49	48	58	24					
PL	17	18	23	16					
PI	32	30	35	8					
NAT. W/C	16.1	18.6	19.5	8.8					
SPEC. GRAVITY	2.68	2.71	----	----					
CLASSIF.SYMB.	CL	CL	CH	SC					
SAMPLE NO.	B-1	B-2	B-1	B-2*					
DEPTH, FT.	3.0-6.0	7.5-11.0	1.0-2.0	2.0-3.5					
HOLE NO.	TP-9	TP-9	TP-11	TP-11					



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SPILLWAY ENLARGEMENT

GRADATION TEST RESULTS

PROJECT NO.
SCV-124A

DATE
AUGUST 1983

FIGURE NO.
B-9

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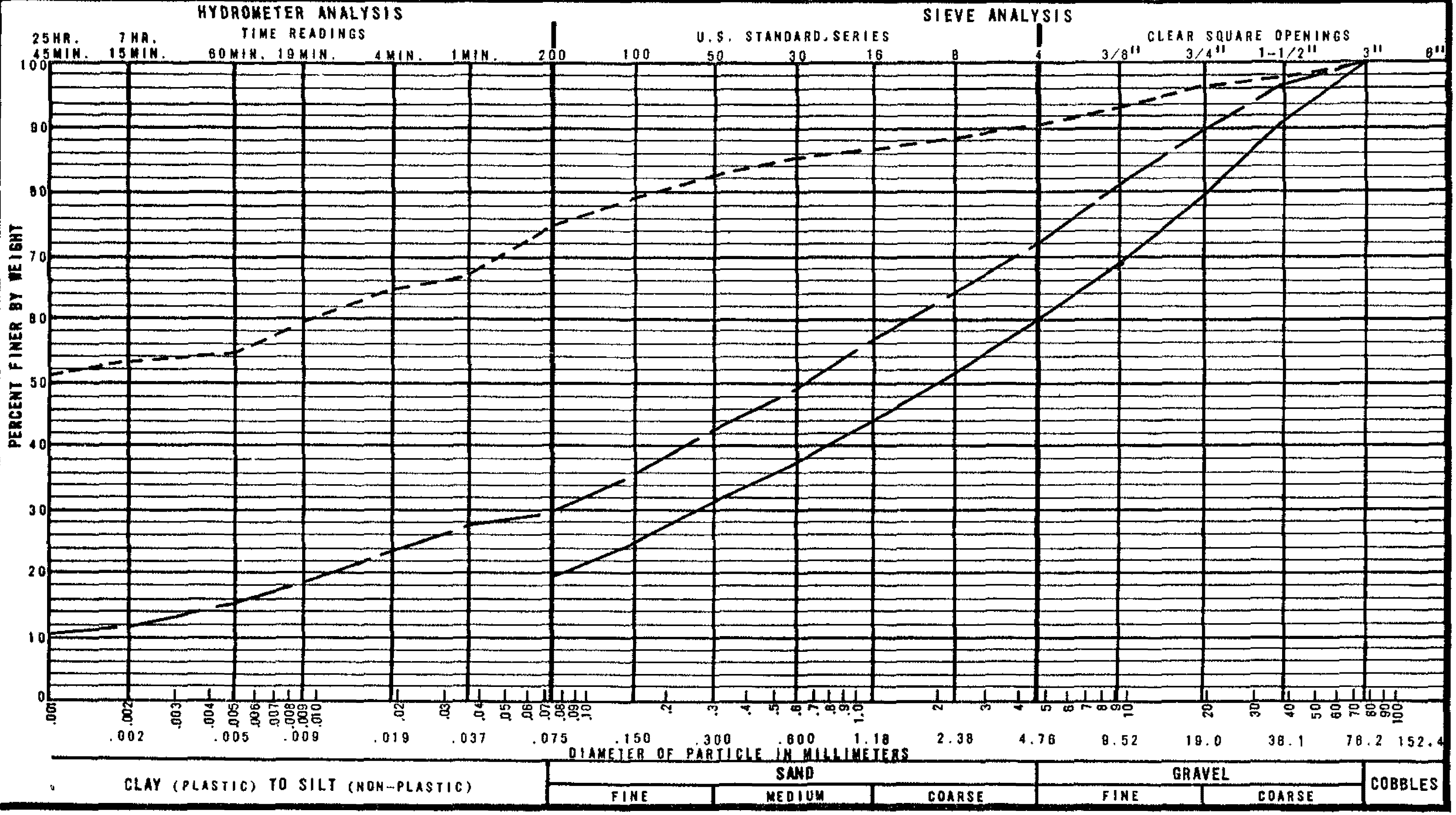
GRADATION TEST RESULTS

PROJECT NO. SCV-124A

DATE AUGUST 1983

FIGURE NO. B-10

KEY:	———	– – – –	— — —						
LL	48	84	73						
PL	35	31	38						
PI	13	53	35						
NAT. W/C	15.1	28.7	26.8						
SPEC. GRAVITY	2.63	----	----						
CLASSIF.SYMB.	SM	CH	SM						
SAMPLE NO.	B-1	B-2	B-3						
DEPTH, FT.	2.0-5.5	6.0-9.0	9.0-11.5						
HOLE NO.	TP-14	TP-14	TP-14						



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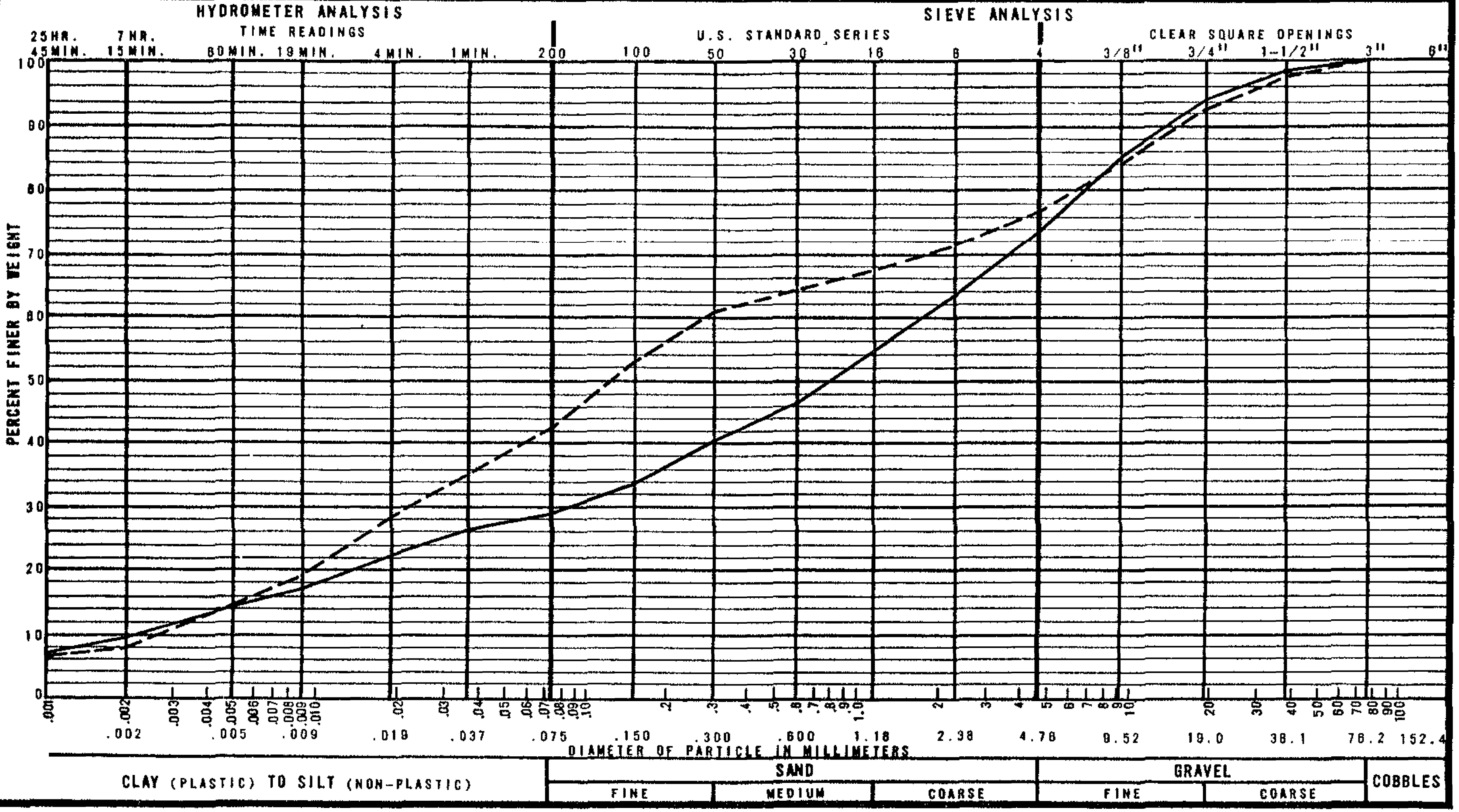
GRADATION TEST RESULTS

PROJECT NO. SCV-124A
DATE AUGUST 1983
FIGURE NO. B-11

KEY:	———	– – –							
LL	88	31							
PL	42	19							
PI	46	12							
NAT. W/C	43.8	21.4							
SPEC. GRAVITY	----	----							
CLASSIF.SYMB.	SM	SC							
SAMPLE NO.	B-1	B-2							
DEPTH, FT.	2.0-4.0	4.0-8.0							
HOLE NO.	TP-15	TP-15							



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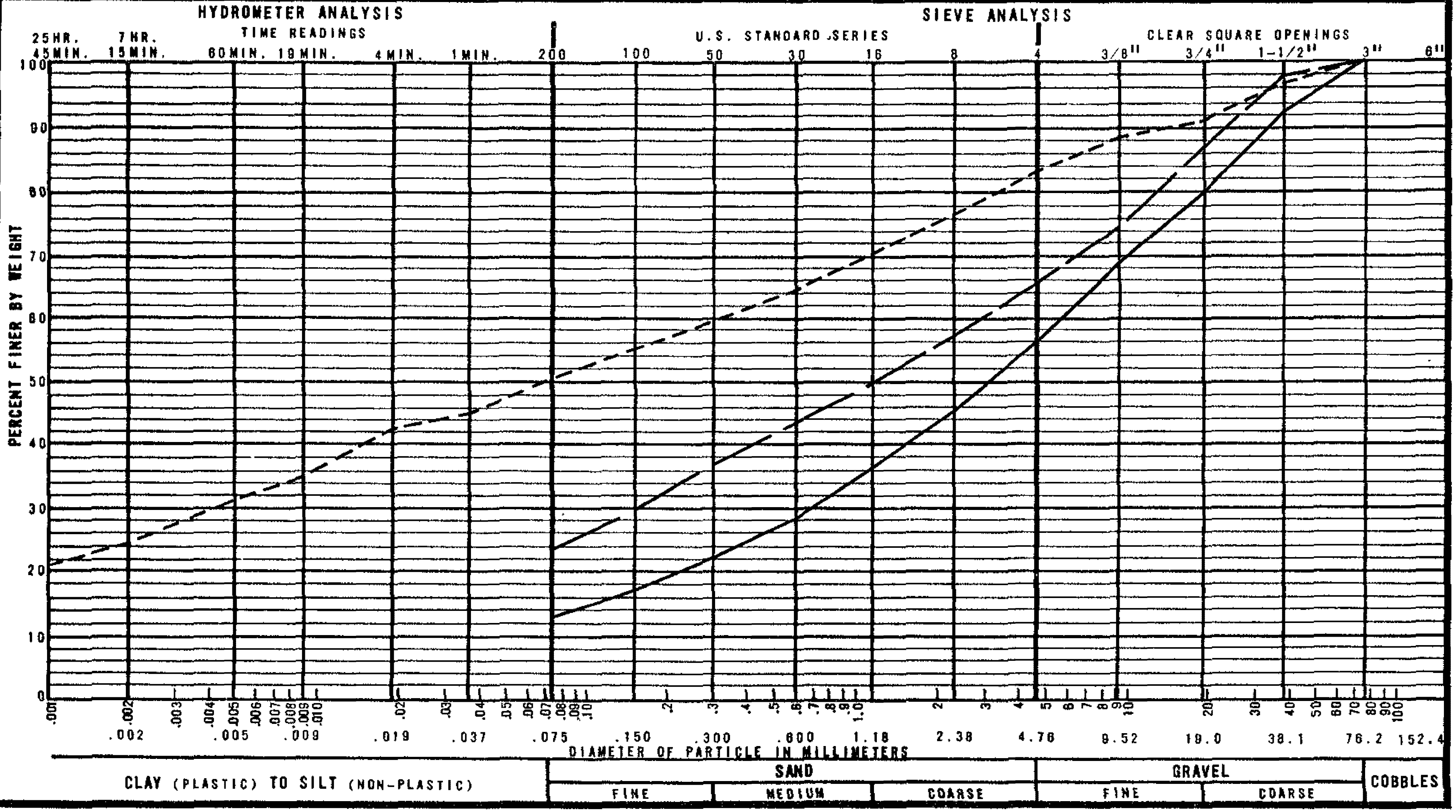
GRADATION TEST RESULTS

PROJECT NO. SCV-124A

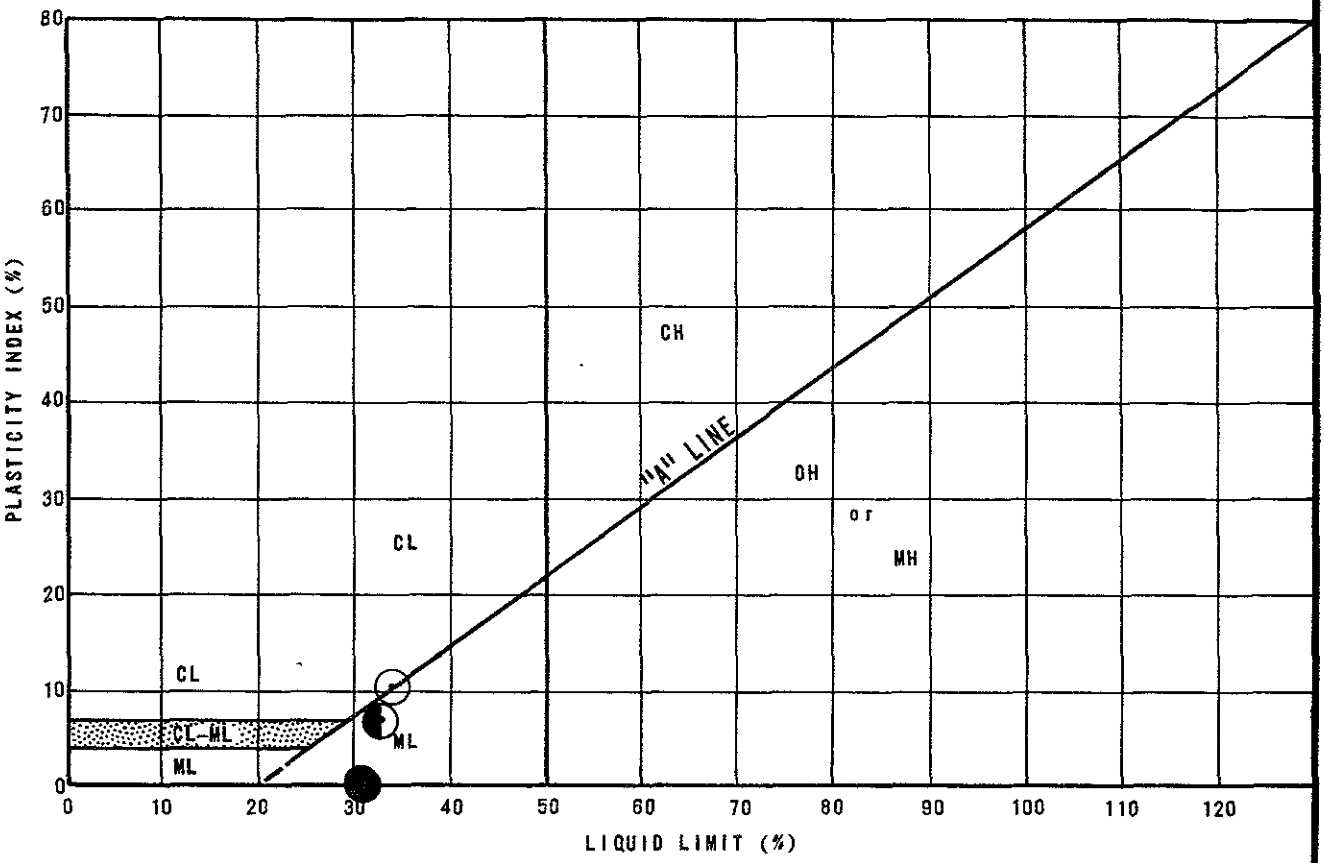
DATE AUGUST 1983

FIGURE NO. B-12

KEY:	————	- - - - -	—— ——						
LL	58	72	40						
PL	34	33	27						
PI	24	39	13						
NAT. W/C	20.1	30.5	13.8						
SPEC. GRAVITY	----	----	----						
CLASSIF. SYMB.	SM	CH-MH	SM-SC						
SAMPLE NO.	B-1	B-1	B-2						
DEPTH, FT.	2.0-4.0	4.0-8.0	0-4.0						
HOLE NO.	T-1	T-11	T-11						



PLASTICITY CHART



PLASTICITY DATA

KEY SYMBOL	HOLE NO., SAMPLE NO.	DEPTH (ft)	NATURAL WATER CONTENT W (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LIQUIDITY INDEX $\left(\frac{W - PL}{LL - PL}\right)$	UNIFIED SOIL CLASSIFICATION SYMBOL
⊙	DH-7-1, B-1	1.20-2.35	25.5	23	34	11	----	SC-SM
●	DH-7-2, B-1	1.35-1.55	14.6	31	31	0	----	SM
◐	DH-7-3, B-2	1.35-1.50	16.7	26	33	7	----	SM

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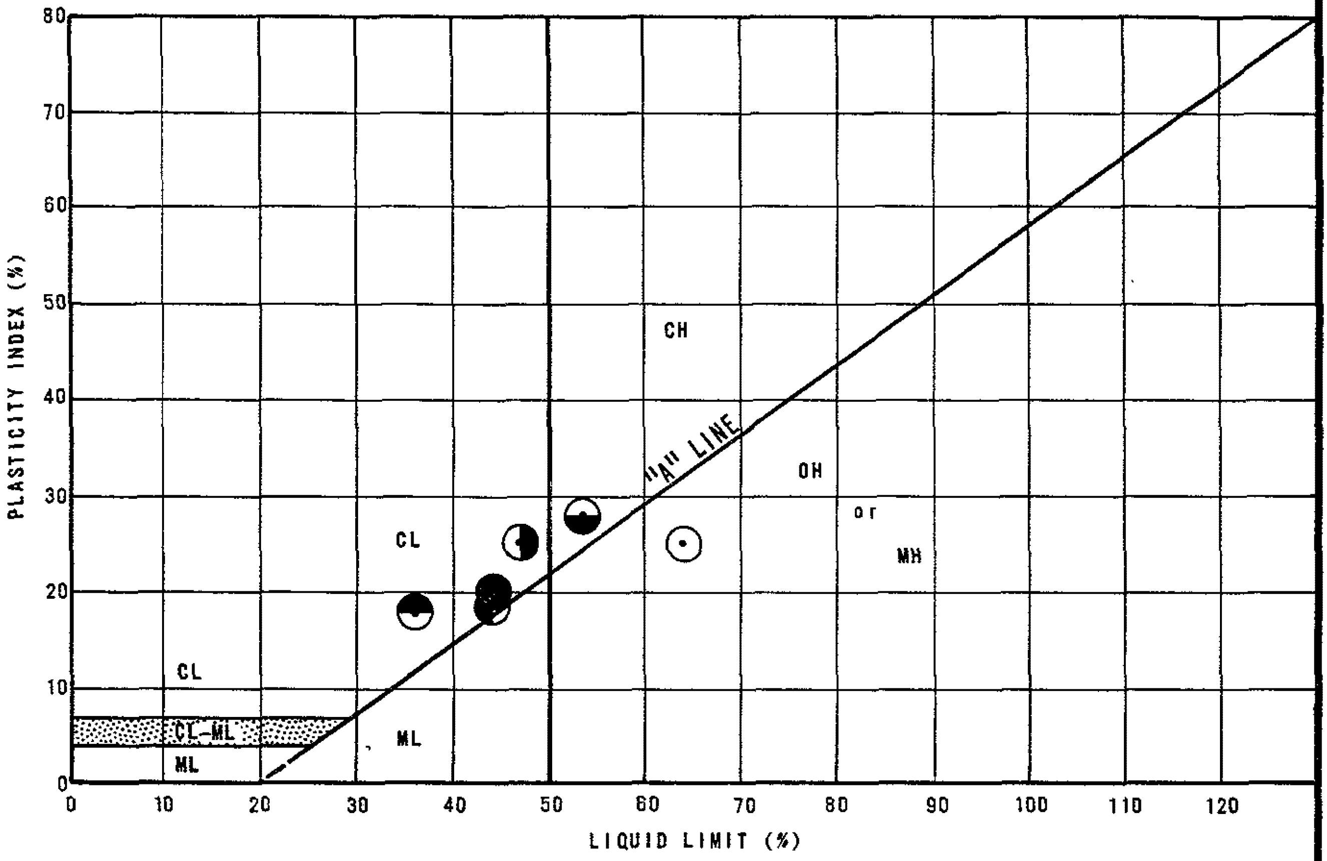
ATTERBERG LIMITS - PLASTICITY DATA

PROJECT NO.	DATE	FIGURE NO.
SCV-124A	OCTOBER 1983	B-13

PLASTICITY CHART



PLASTICITY DATA

KEY SYMBOL	HOLE NO., SAMPLE NO.	DEPTH (ft)	NATURAL WATER CONTENT W (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LIQUIDITY INDEX $\left(\frac{W - PL}{LL - PL}\right)$	UNIFIED SOIL CLASSIFICATION SYMBOL
⊙	AD-1, S-3	12.5-15.0	37.4	39	64	25	----	SM
●	AD-10, B-3	5.0-6.5	13.8	24	44	20	----	SC
◐	AD-11, B-1	2.0-3.5	14.9	25	44	19	----	SC-SM
◕	AD-12, B-4	5.2-6.7	14.6	22	47	25	----	SC
◓	AD-13, B-1	1.5-2.0	6.4	18	36	18	----	GC
◒	AD-13, B-3	3.3-4.8	18.2	25	53	28	----	SC

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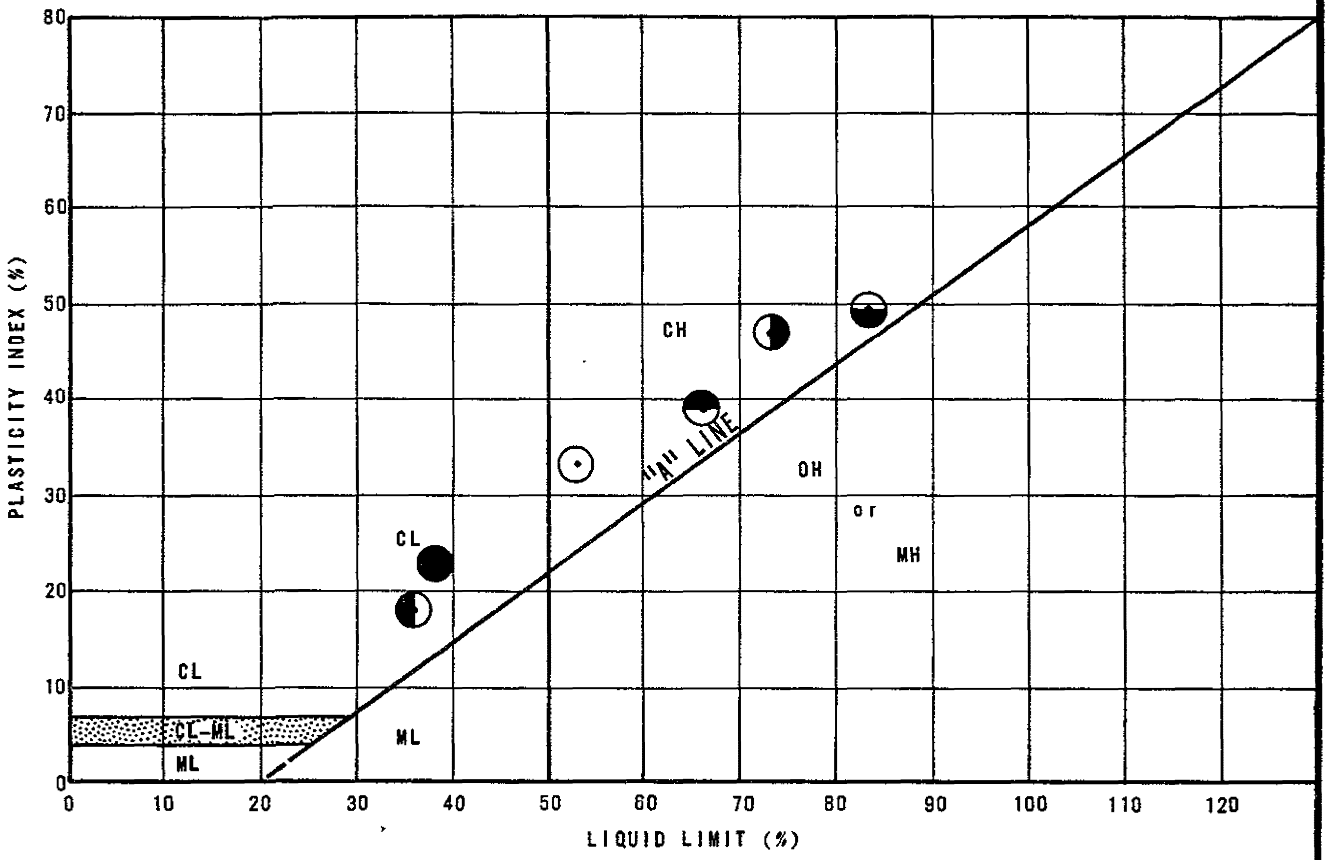
ATTERBERG LIMITS - PLASTICITY DATA

PROJECT NO.	DATE	FIGURE NO.
SCV-124A	SEPTEMBER 1983	B-14

PLASTICITY CHART



PLASTICITY DATA

KEY SYMBOL	HOLE NO., SAMPLE NO.	DEPTH (ft)	NATURAL WATER CONTENT W (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LIQUIDITY INDEX $\left(\frac{W-PL}{LL-PL}\right)$	UNIFIED SOIL CLASSIFICATION SYMBOL
⊙	TP-2, B-1	1.0-2.0	17.8	20	53	33	----	CH
●	TP-2, B-2	3.0-4.5	15.4	15	38	23	----	CL
◐	TP-2, B-3	4.5-6.0	12.8	18	36	18	----	GC
◑	TP-3, B-1	1.5-5.5	30.7	26	73	47	----	CH
◓	TP-3, B-2	5.5-9.0	28.2	27	66	39	----	CH
◒	TP-3, B-3	10.0-12.5	32.6	34	83	49	----	CH

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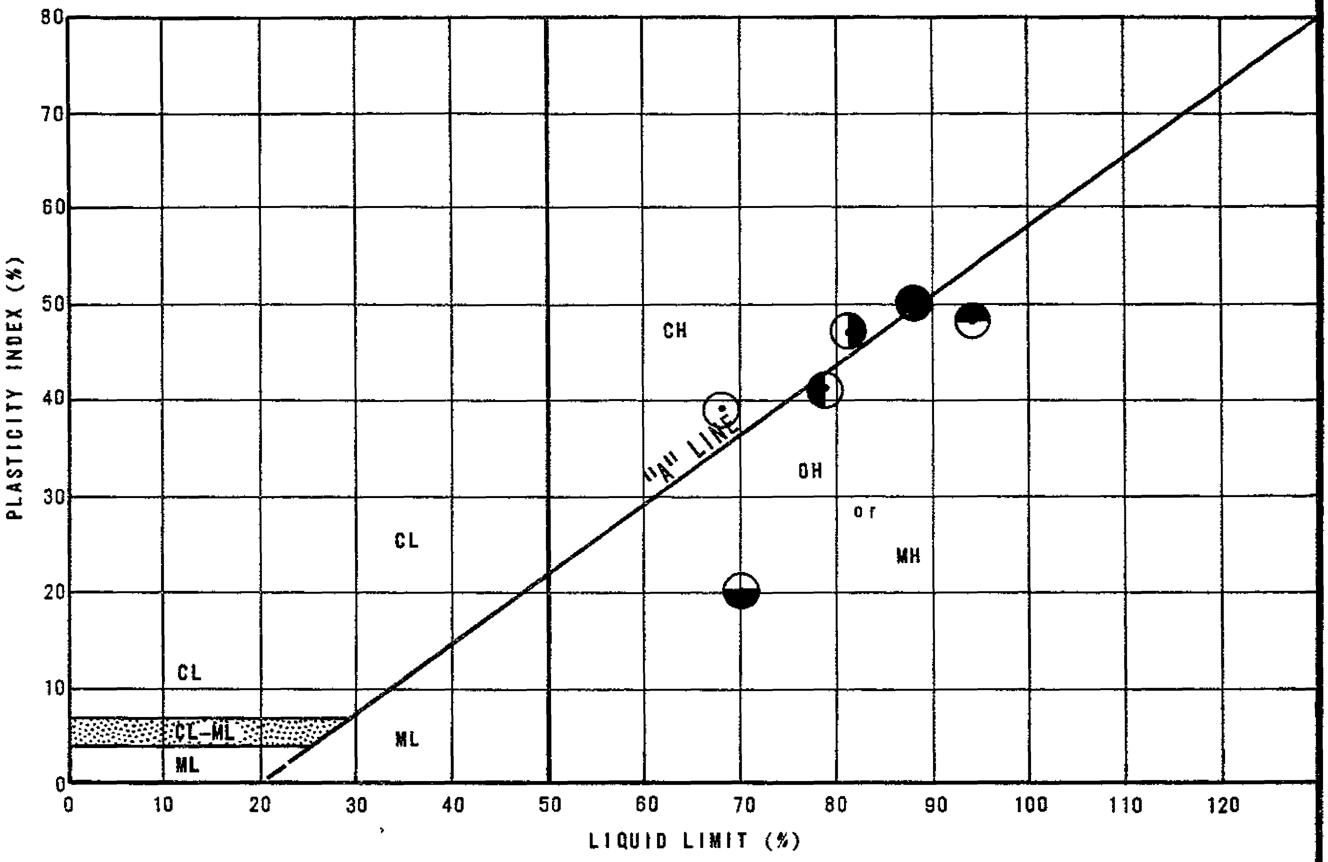
ATTERBERG LIMITS - PLASTICITY DATA

PROJECT NO.	DATE	FIGURE NO.
SCV-124A	JULY 1983	B-15

PLASTICITY CHART



PLASTICITY DATA

KEY SYMBOL	HOLE NO., SAMPLE NO.	DEPTH (ft)	NATURAL WATER CONTENT W (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LIQUIDITY INDEX $\left(\frac{W - PL}{LL - PL}\right)$	UNIFIED SOIL CLASSIFICATION SYMBOL
⊙	TP-5, B-1	1.0-3.5	24.2	29	68	39	----	CH
●	TP-5, B-2	5.0-9.0	36.1	38	88	50	----	CH-MH
◐	TP-5, B-3	10.0-12.5	36.6	38	79	41	----	MH
◑	TP-6, B-1	1.0-2.5	30.3	34	81	47	----	CH
◓	TP-6, B-2	3.5-6.5	44.1	46	94	48	----	MH
◒	TP-6, B-3	8.0-10.0	44.5	50	70	20	----	MH

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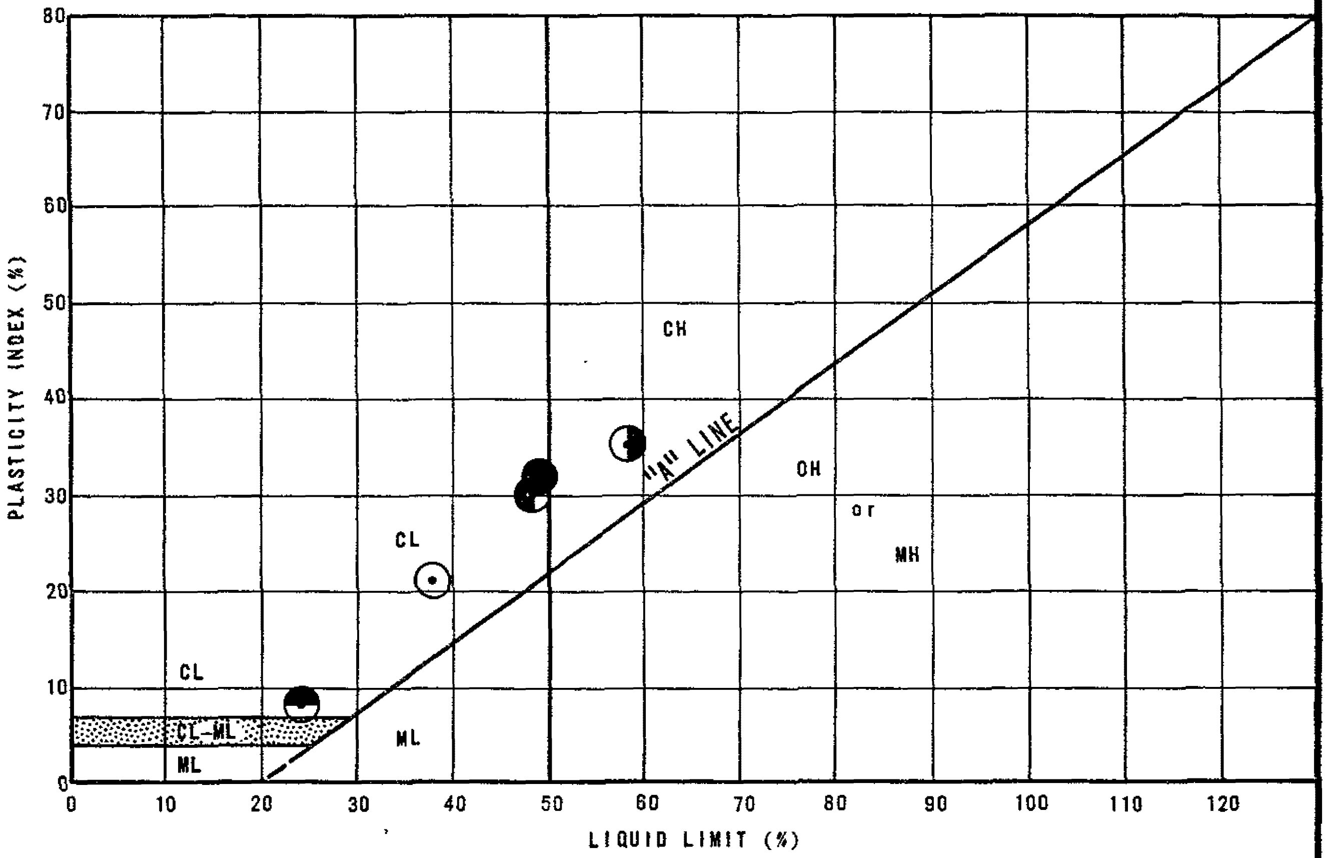
ATTERBERG LIMITS - PLASTICITY DATA

PROJECT NO.	DATE	FIGURE NO.
SCV-124A	JULY 1983	B-16

PLASTICITY CHART



PLASTICITY DATA

KEY SYMBOL	HOLE NO., SAMPLE NO.	DEPTH (ft)	NATURAL WATER CONTENT W (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LIQUIDITY INDEX $\left(\frac{W-PL}{LL-PL}\right)$	UNIFIED SOIL CLASSIFICATION SYMBOL
⊙	TP-7, B-1	7.5-10.0	16.0	17	38	21	----	CL
●	TP-9, B-1	3.0-6.0	16.1	17	49	32	----	CL
◐	TP-9, B-2	7.5-11.0	18.6	18	48	30	----	CL
◑	TP-11, B-1	1.0-2.0	19.5	23	58	35	----	CH
◓	TP-11, B-2	2.0-3.5	8.8	16	24	8	----	SC

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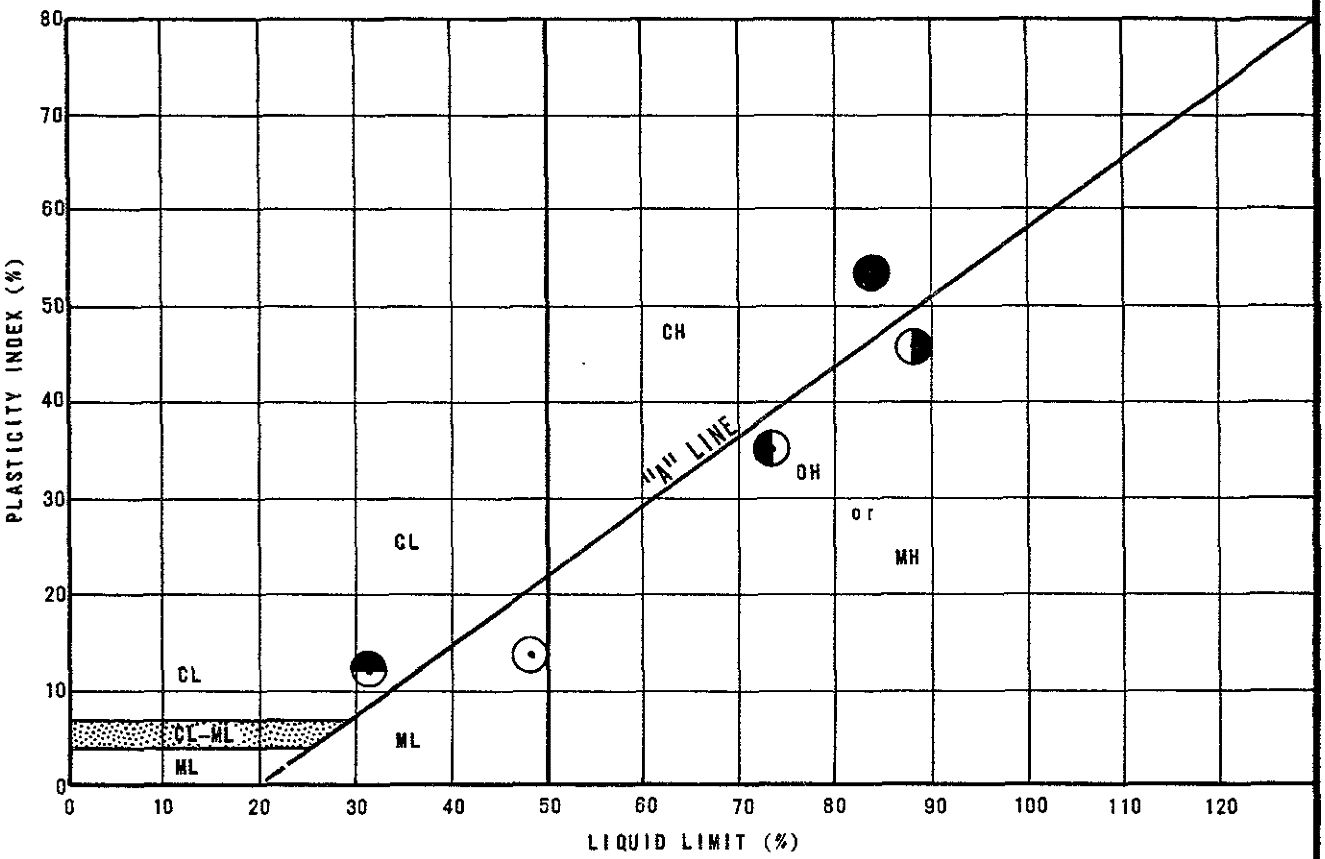
ATTERBERG LIMITS - PLASTICITY DATA

PROJECT NO.	DATE	FIGURE NO.
SCV-124A	AUGUST 1983	B-17

PLASTICITY CHART



PLASTICITY DATA

KEY SYMBOL	HOLE NO., SAMPLE NO.	DEPTH (ft)	NATURAL WATER CONTENT W (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LIQUIDITY INDEX $\left(\frac{W-PL}{LL-PL}\right)$	UNIFIED SOIL CLASSIFICATION SYMBOL
⊙	TP-14, B-1	2.0-5.5	15.1	35	48	13	----	SM
●	TP-14, B-2	6.0-9.0	28.7	31	84	53	----	CH
◐	TP-14, B-3	9.0-11.5	26.8	38	73	35	----	SM
◑	TP-15, B-1	2.0-4.0	43.8	42	88	46	----	SM
◓	TP-15, B-2	4.0-8.0	21.4	19	31	12	----	SC

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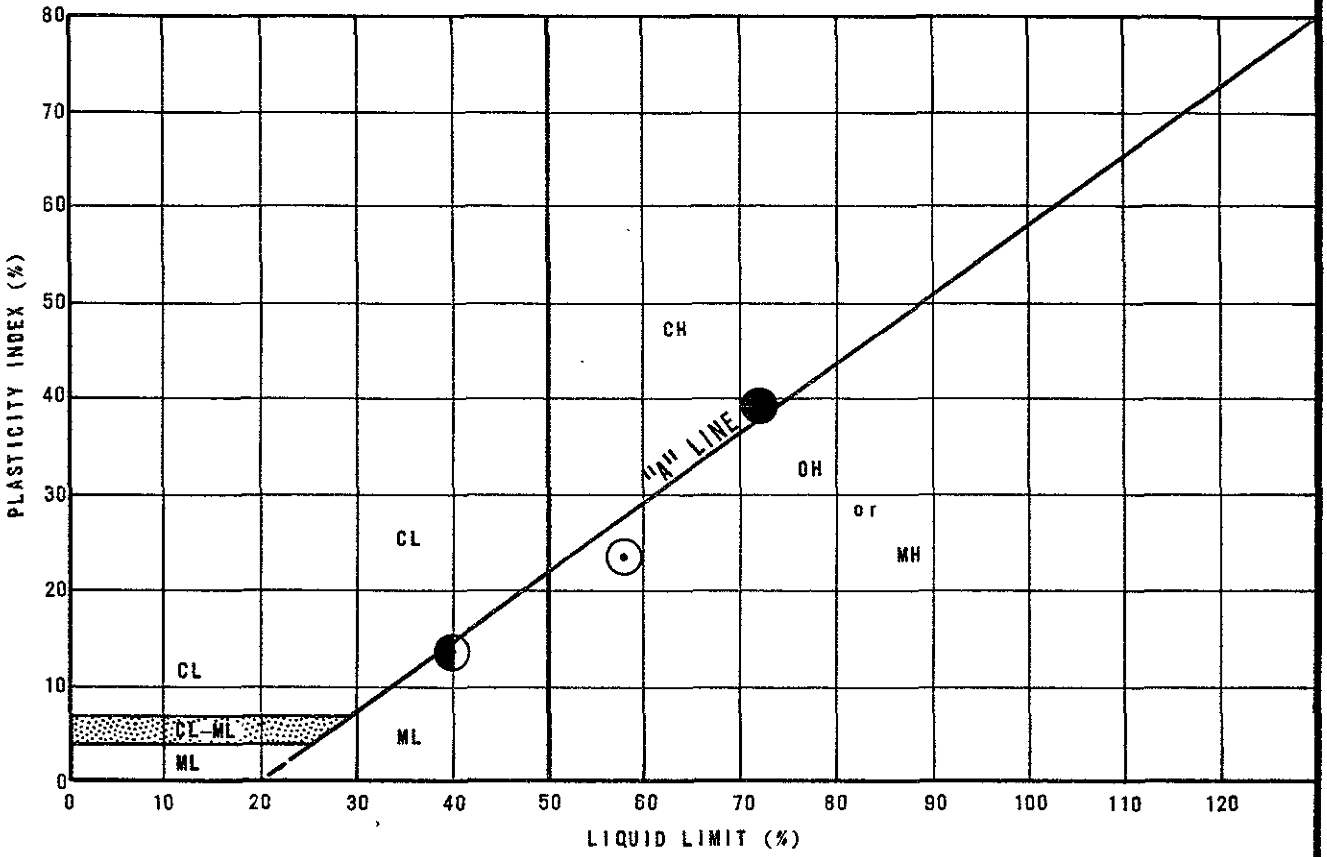
ATTERBERG LIMITS - PLASTICITY DATA

PROJECT NO.	DATE	FIGURE NO.
SCV-124A	AUGUST 1983	B-18

PLASTICITY CHART



PLASTICITY DATA

KEY SYMBOL	HOLE NO., SAMPLE NO.	DEPTH (ft)	NATURAL WATER CONTENT W (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	LIQUIDITY INDEX $\left(\frac{W - PL}{LL - PL}\right)$	UNIFIED SOIL CLASSIFICATION SYMBOL
⊙	T-1, B-1	2.0-4.0	20.1	34	58	24	----	SM
●	T-11, B-1	4.0-8.0	30.5	33	72	39	----	CH-MH
◐	T-11, B-2	0.0-4.0	13.8	27	40	13	----	SM-SC

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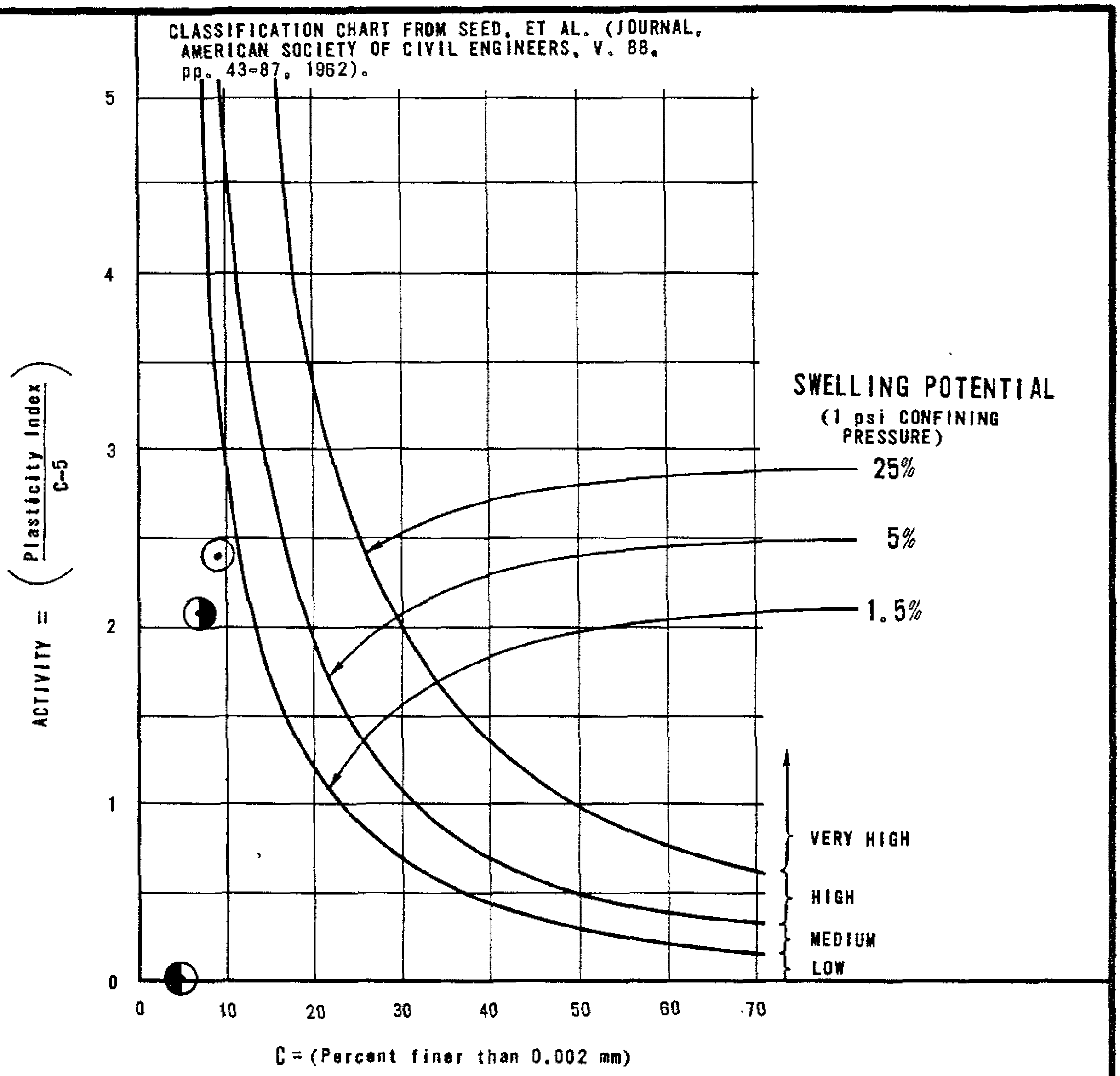
ATTERBERG LIMITS - PLASTICITY DATA

PROJECT NO.	DATE	FIGURE NO.
SCV-124A	AUGUST 1983	B-19


CLASSIFICATION CHART FROM SEED, ET AL. (JOURNAL, AMERICAN SOCIETY OF CIVIL ENGINEERS, V. 88, pp. 43-87, 1962).

KEY SYMBOL	HOLE NO., SAMPLE NO.	DEPTH (feet)	PLASTICITY INDEX	C	ACTIVITY	SWELLING POTENTIAL
⊙	DH-7-1, B-1	1.20-2.35	11	9.5	2.4	LOW
◐	DH-7-2, B-1	1.35-1.55	0	5.1	0	LOW
◑	DH-7-3, B-2	1.50-1.90	7	8.3	2.1	LOW

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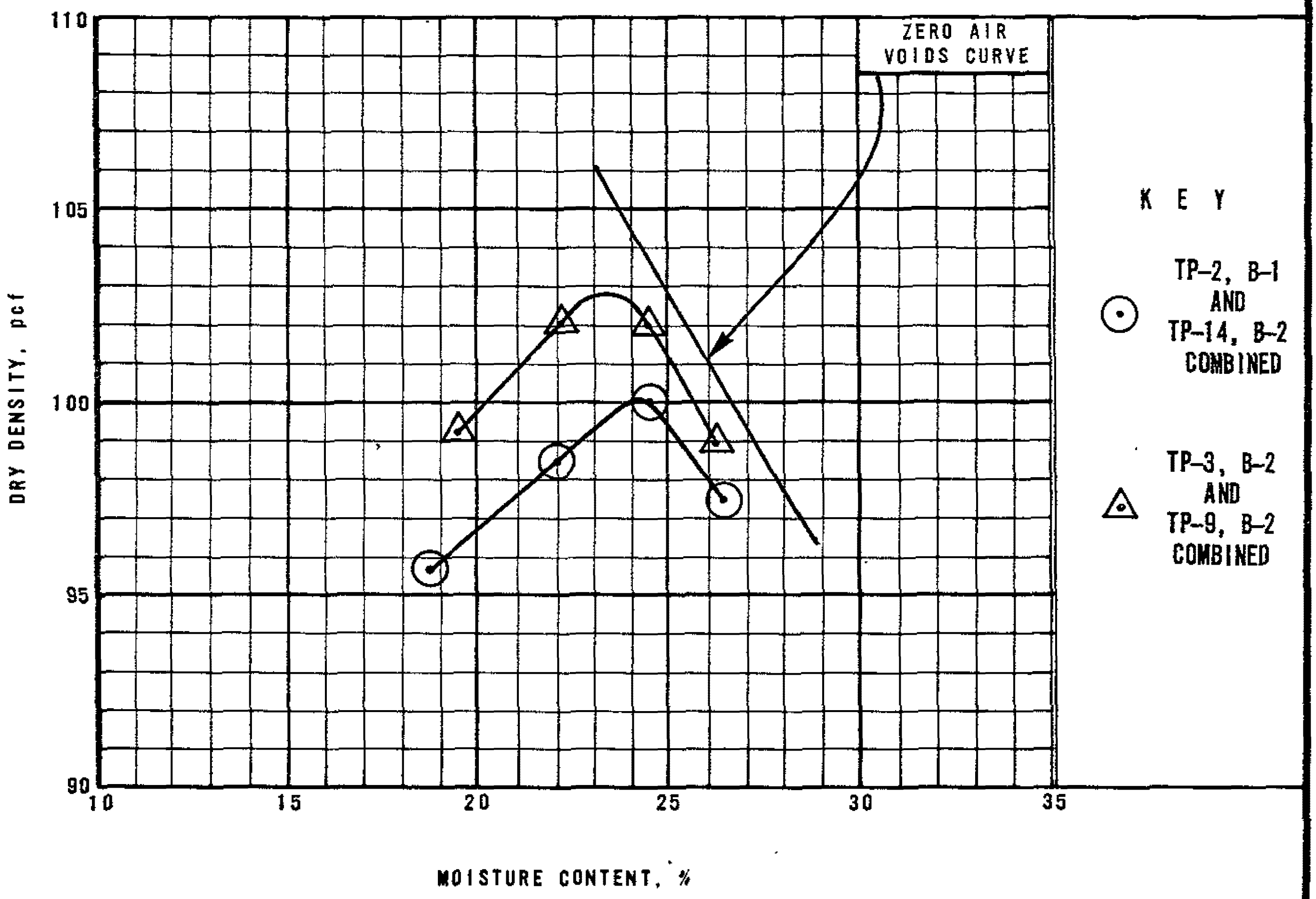
SWELLING POTENTIAL

PROJECT NO	DATE	FIGURE NO.
SCV-124A	NOVEMBER 1983	B-20

SAMPLE	SAMPLE DESCRIPTION	SPECIFIC GRAVITY	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PERCENT PASSING	
					NO. 4	NO. 200
TP-2, B-1, AND TP-14, B-2 COMBINED	SANDY CLAY, DARK BROWN MOTTLED YELLOW BROWN (CH)	2.8 (est.)	69 (avg.)	26 (avg.)	94.4 (avg.)	71.1 (avg.)
TP-3, B-2, AND TP-9, B-2 COMBINED	SANDY CLAY, DARK BROWN MOTTLED YELLOW BROWN (CH)	2.8 (est.)	57 (avg.)	23 (avg.)	96.7 (avg.)	73.1 (avg.)



* MODIFIED TO 20,000 ft-lbs/ft^3 COMPACTIVE ENERGY

SAMPLE	TP-2, B-1, AND TP-14, B-2 COMBINED	TP-3, B-2, AND TP-9, B-2 COMBINED	
NATURAL WATER CONTENT, % (avg.)	23.3	23.4	
OPTIMUM WATER CONTENT, %	24.2	23.3	
MAXIMUM DRY DENSITY, pcf	100.0	102.8	
TEST DESIGNATION ASTM	D1557-78* METHOD A	D1557-78* METHOD A	

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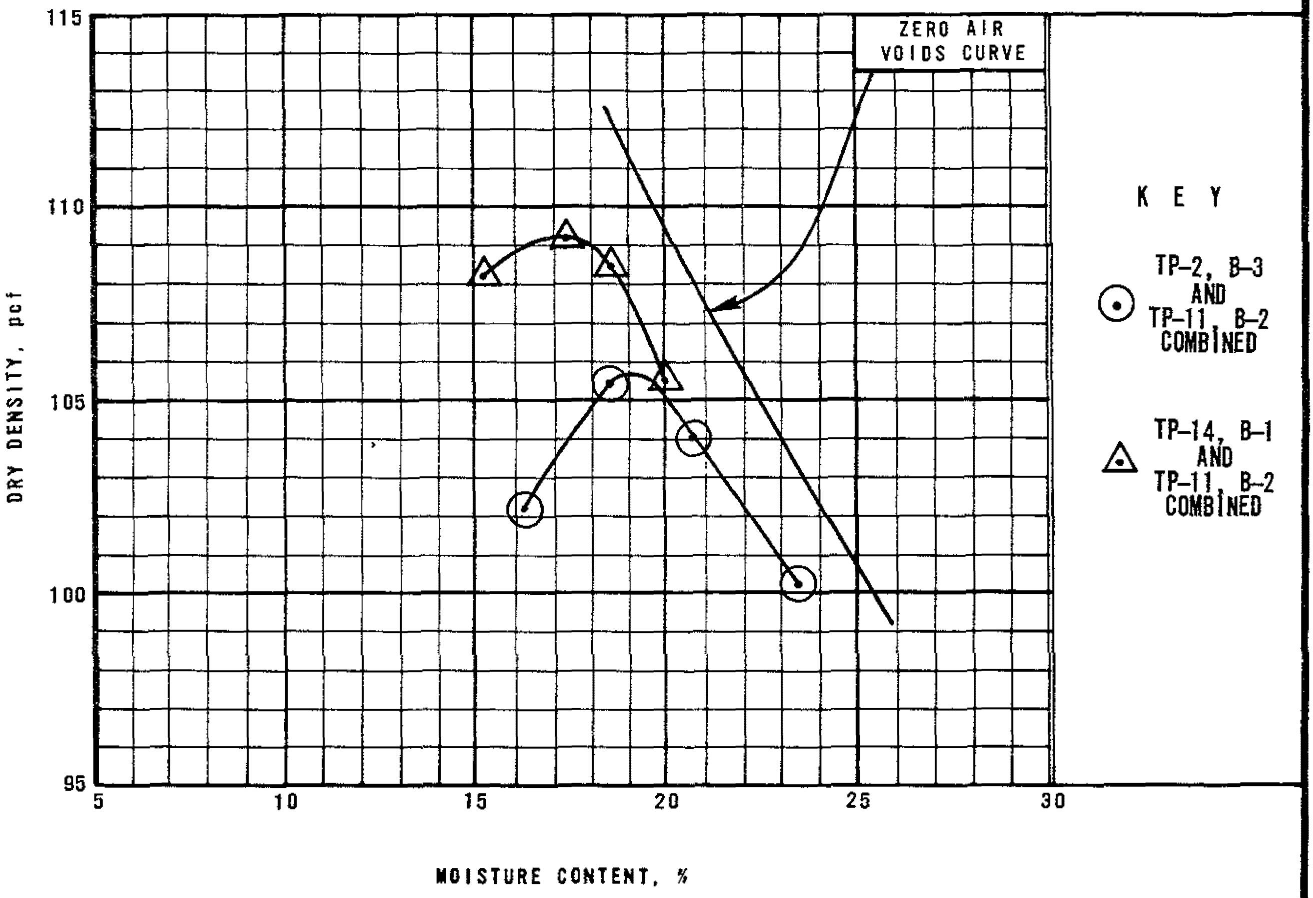
COMPACTION TEST RESULTS

PROJECT NO.	DATE	FIGURE NO.
SCV-124A	NOVEMBER 1983	B-21

SAMPLE	SAMPLE DESCRIPTION	SPECIFIC GRAVITY	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PERCENT PASSING	
					NO. 4	NO. 200
TP-2, B-3, AND TP-11, B-2 COMBINED	CLAYEY SAND, GRAY BROWN (SC)	2.7 (est.)	30 (avg.)	17 (avg.)	1) 67.7 2) 85.7	1) 27.4 2) 35.3
TP-14, B-1, AND TP-11, B-2 COMBINED	GRAVELLY SILTY SAND, DARK BROWN TO GRAY (SM)	2.7 (est.)	44 (avg.)	31 (avg.)	1) 62.7 2) 75.6	1) 21.5 2) 25.9

1) AS RECEIVED (AVERAGE)
2) AS TESTED (AVERAGE, SCALPED ON ¾" SIEVE)



* MODIFIED TO 20,000 ft-lbs/ft^3 COMPACTIVE ENERGY

SAMPLE NO.	TP-2, B-3, AND TP-11, B-2 COMBINED	TP-14, B-1, AND TP-11, B-2 COMBINED	
NATURAL WATER CONTENT, % (avg.)	9.6	14.5	
OPTIMUM WATER CONTENT, %	19.0	17.0	
MAXIMUM DRY DENSITY, pcf	105.7	109.2	
TEST DESIGNATION ASTM	D1557-78* METHOD C	D1557-78* METHOD C	

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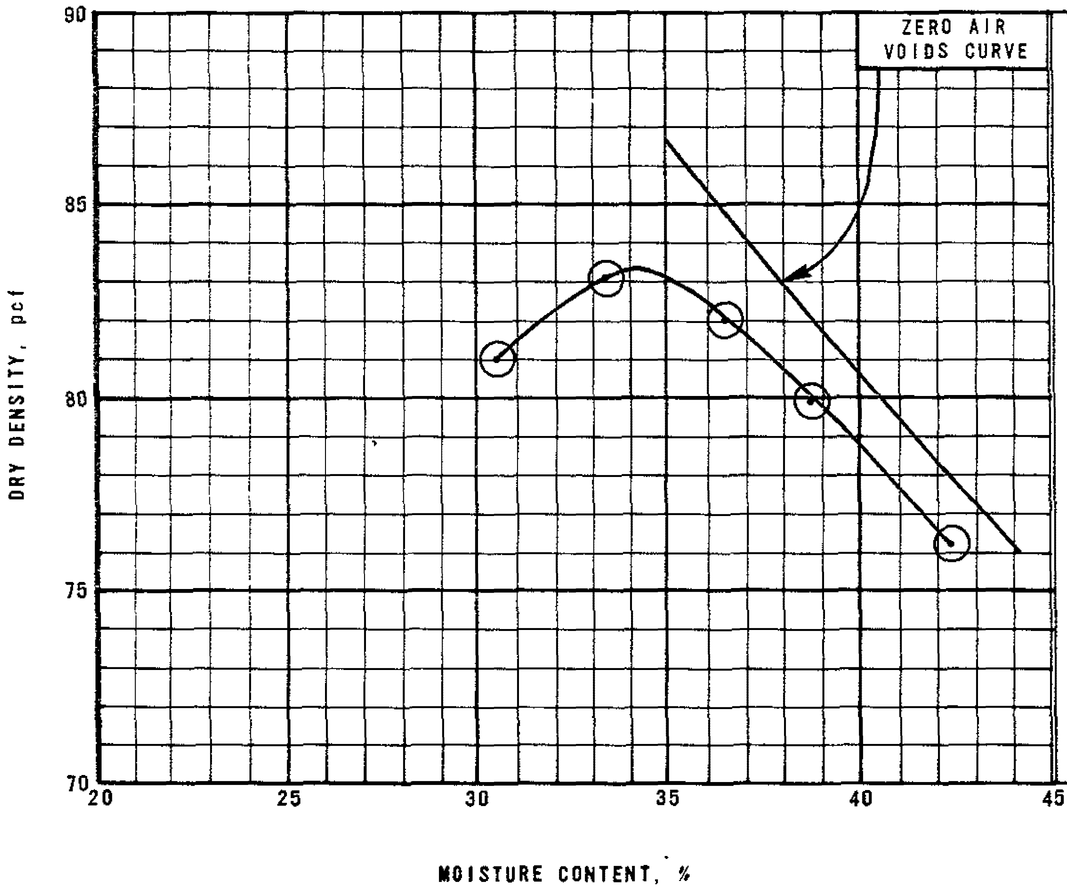
COMPACTION TEST RESULTS

PROJECT NO.	DATE	FIGURE NO.
SCV-124A	NOVEMBER 1983	B-22

SAMPLE	SAMPLE DESCRIPTION	SPECIFIC GRAVITY	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PERCENT PASSING NO. 4	PERCENT PASSING NO. 200
TP-14, B-3, AND TP-15, B-1 COMBINED	CLAYEY SAND, BROWN (WITH SERPENTINE) (SM)	2.7 (est.)	81 (avg.)	40 (avg.)	1) 72.9 2) 79.3	1) 29.4 2) 32.0

1) AS RECEIVED (AVERAGE)

2) AS TESTED (AVERAGE, SCALPED ON ¾" SIEVE)



KEY

* MODIFIED TO 20,000 ft-lbs/ft^3 COMPACTIVE ENERGY

SAMPLE	TP-14, B-3, AND TP-15, B-1 COMBINED		
NATURAL WATER CONTENT, % (avg.)	35.3		
OPTIMUM WATER CONTENT, %	34.2		
MAXIMUM DRY DENSITY, pcf	83.3		
TEST DESIGNATION ASTM	D1557-78* METHOD C		

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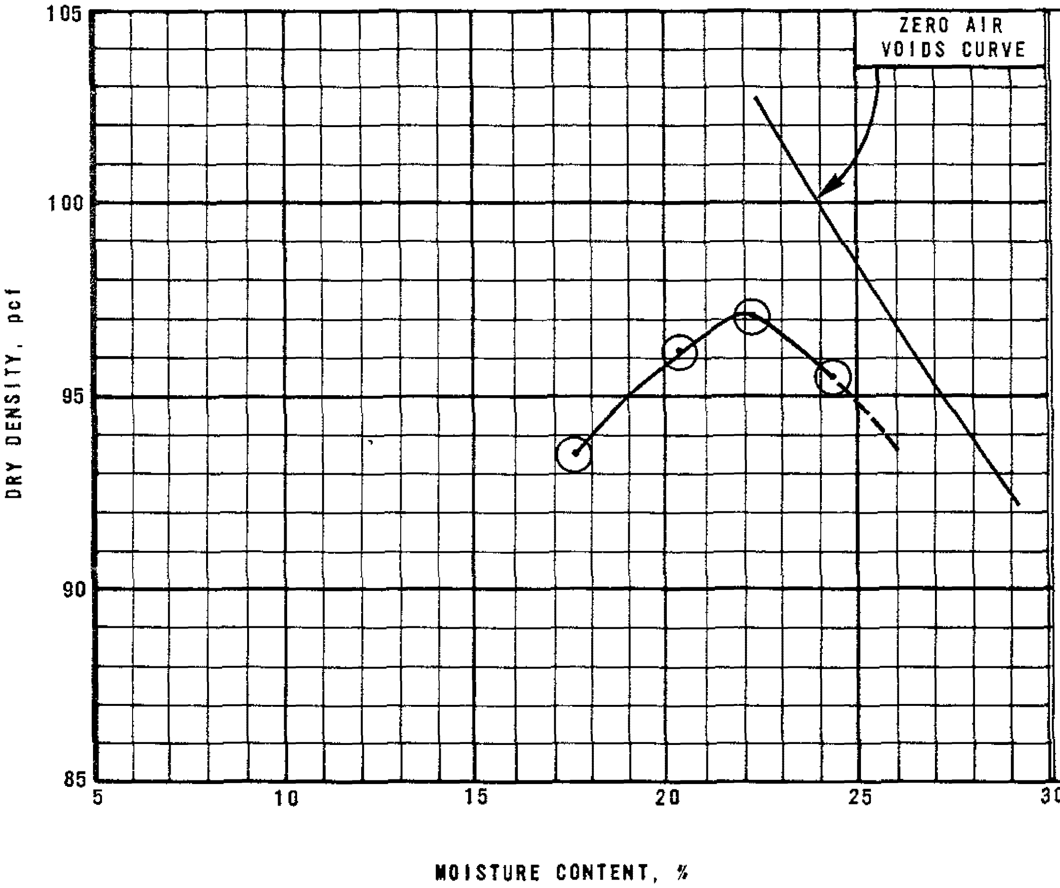
COMPACTION TEST RESULTS

PROJECT NO.	DATE	FIGURE NO.
SCV-124A	NOVEMBER 1983	B-23

HOLE NO.	SAMPLE NO.	DEPTH (ft)	SAMPLE DESCRIPTION	SPECIFIC GRAVITY	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PERCENT PASSING NO. 4	PERCENT PASSING NO. 200
T-1	B-1	2.0-4.0	GRAVELLY SILTY SAND, YELLOW BROWN (SOME CEMENTED SANDSTONE) (SM)	2.6 (est.)	58	34	1) 55.9 2) 70.0	1) 13.3 2) 16.7

1) AS RECEIVED
2) AS TESTED (SCALPED ON ¾" SIEVE)



KEY

* MODIFIED TO 20,000 ft-lbs/ft^3 COMPACTIVE ENERGY

HOLE NO., SAMPLE NO.		T-1, B-1 @ 2.0'-4.0'		
NATURAL WATER CONTENT, %		20.1		
OPTIMUM WATER CONTENT, %		22.0		
MAXIMUM DRY DENSITY, pcf		97.1		
TEST DESIGNATION	ASTM	D1557-78* METHOD C		

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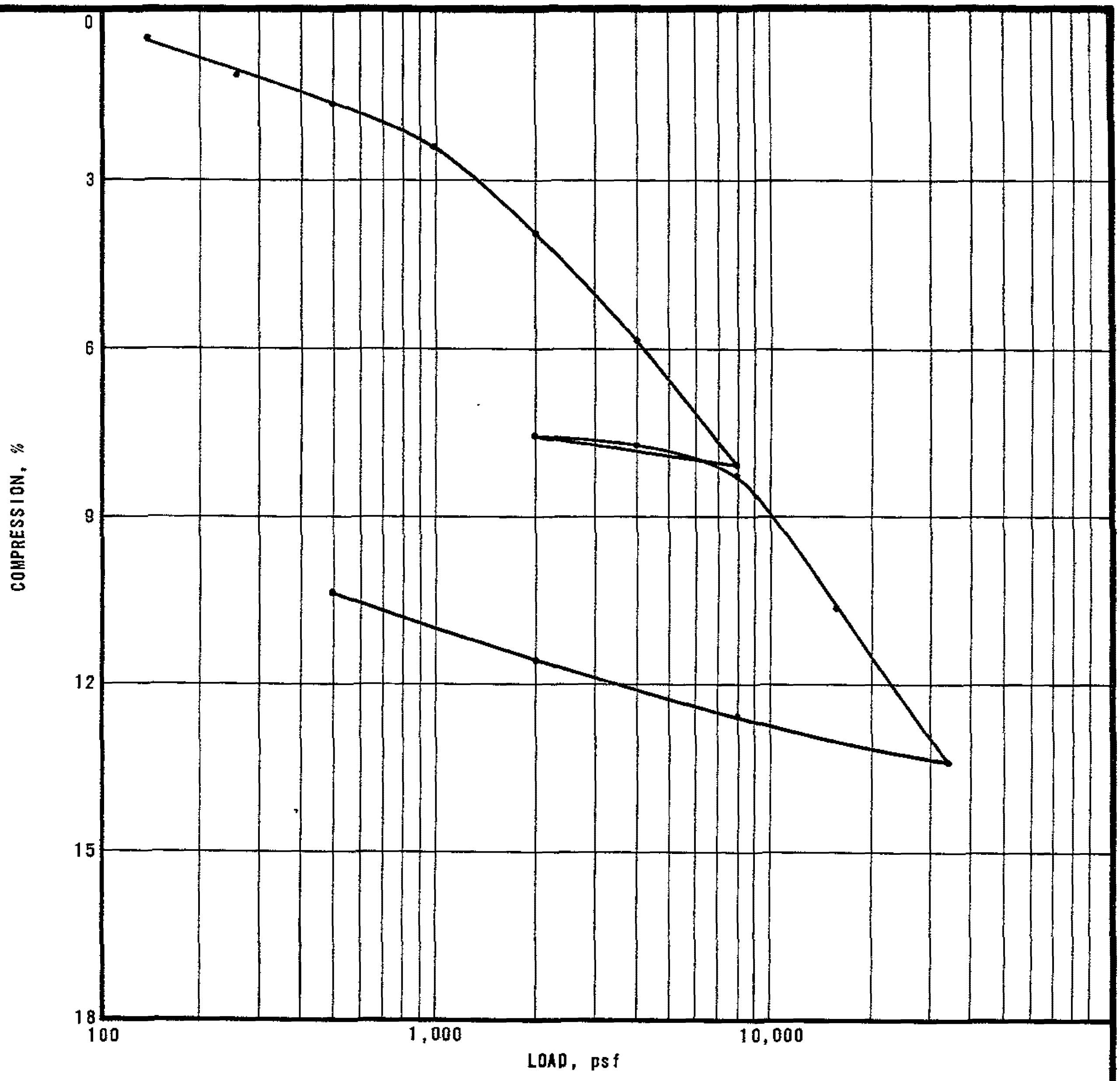
COMPACTION TEST RESULTS

PROJECT NO.	DATE	FIGURE NO.
SCV-124A	NOVEMBER 1983	B-24



NOTE: SAMPLE WAS FLOODED WITH WATER AFTER CONSOLIDATING TO 500 psf. THEREAFTER, SAMPLE WAS ALLOWED TO CONSOLIDATE FOR APPROXIMATELY 24 HOURS UNDER EACH LOAD INCREMENT. FINAL SPECIMEN DATA WERE CALCULATED AT LAST REBOUND INCREMENT.

SAMPLE DESCRIPTION: GRAVELLY CLAYEY SAND, RED BROWN

HOLE NO.	SAMPLE NO.	DEPTH (ft)	INITIAL SPECIMEN DATA			FINAL SPECIMEN DATA		
			DRY DENSITY (pcf)	WATER CONTENT (%)	VOID RATIO	DRY DENSITY (pcf)	WATER CONTENT (%)	DEGREE OF SATURATION (%)
AD-1	S-7	25.0-27.5	80.3	35.9	1.098	89.5	32.7	100

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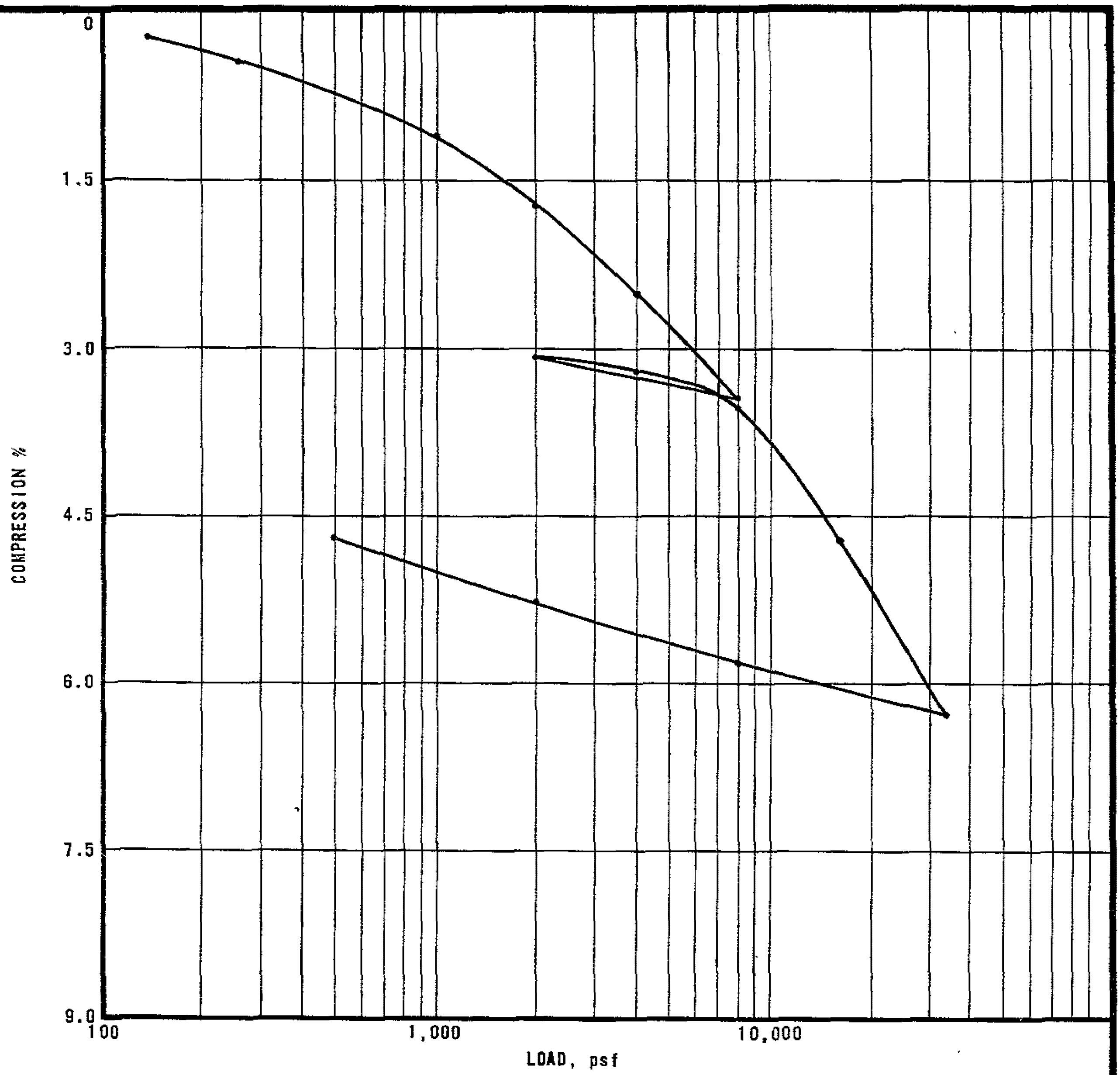
CONSOLIDATION TEST

PROJECT NO.	DATE	FIGURE NO.
SCV-124A	SEPTEMBER 1983	B-25



NOTE: SAMPLE WAS FLOODED WITH WATER AFTER CONSOLIDATING TO 500 psf. THEREAFTER, SAMPLE WAS ALLOWED TO CONSOLIDATE FOR APPROXIMATELY 24 HOURS UNDER EACH LOAD INCREMENT . FINAL SPECIMEN DATA WERE CALCULATED AT LAST REBOUND INCREMENT.

SAMPLE DESCRIPTION: SILTY SAND, PLASTIC, GREENISH GREY

HOLE NO.	SAMPLE NO.	DEPTH (ft)	INITIAL SPECIMEN DATA			FINAL SPECIMEN DATA		
			DRY DENSITY (pcf)	WATER CONTENT (%)	VOID RATIO	DRY DENSITY (pcf)	WATER CONTENT (%)	DEGREE OF SATURATION (%)
AD-2	R-2	27.5-29.0	93.7	27.2	0.798	98.3	26.4	100

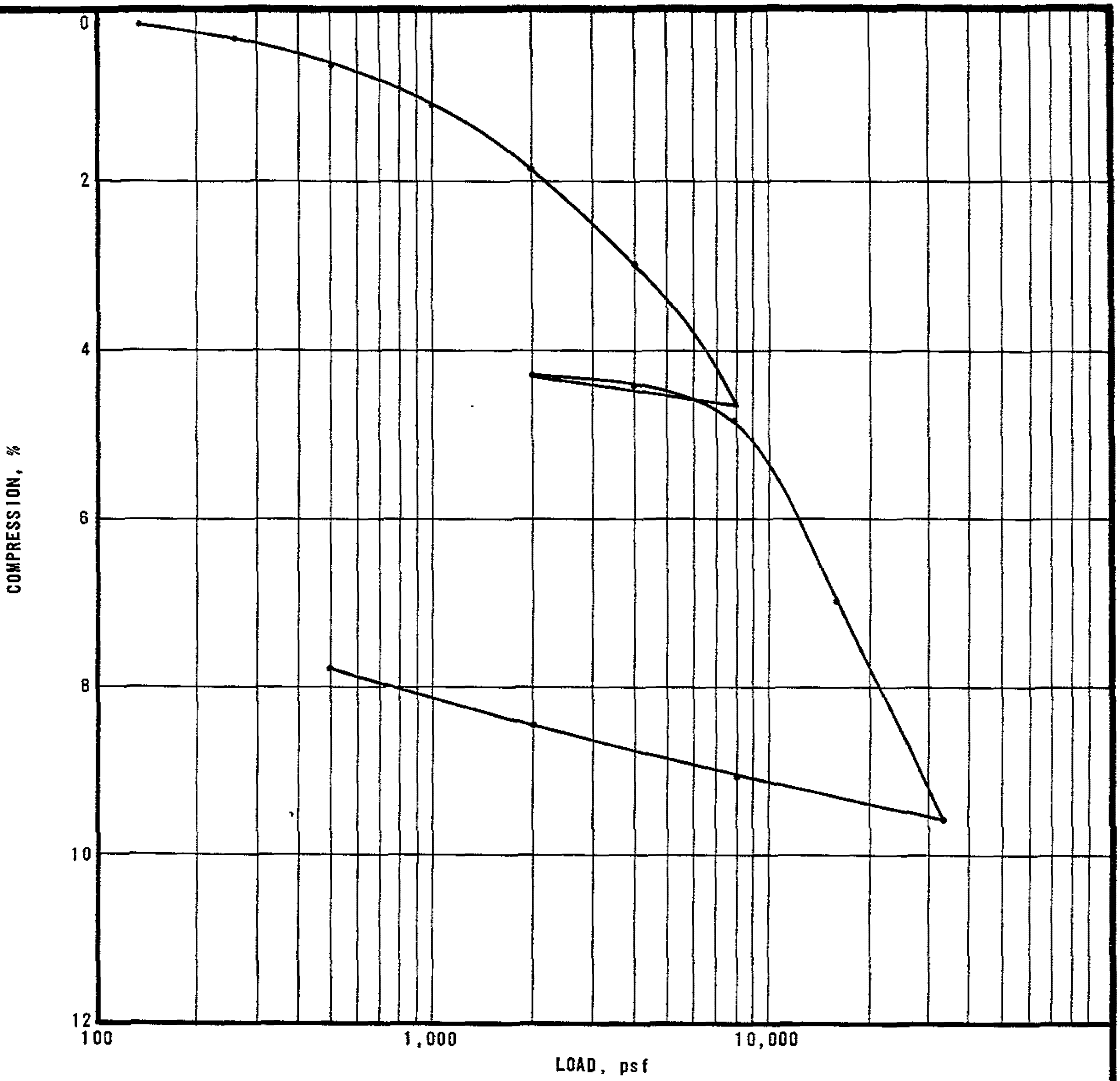
Wahler Associates

ANDERSON DAM
SPILLWAY ENLARGEMENT

PALO ALTO • NEWPORT BEACH • DENVER

CONSOLIDATION TEST

PROJECT NO.	DATE	FIGURE NO.
SCV-124A	SEPTEMBER 1983	B-26



NOTE: SAMPLE WAS FLOODED WITH WATER AFTER CONSOLIDATING TO 500 psf. THEREAFTER, SAMPLE WAS ALLOWED TO CONSOLIDATE FOR APPROXIMATELY 24 HOURS UNDER EACH LOAD INCREMENT. FINAL SPECIMEN DATA WERE CALCULATED AT LAST REBOUND INCREMENT.

SAMPLE DESCRIPTION: SILTY SAND, BROWN

HOLE NO.	SAMPLE NO.	DEPTH (ft)	INITIAL SPECIMEN DATA			FINAL SPECIMEN DATA		
			DRY DENSITY (pcf)	WATER CONTENT (%)	VOID RATIO	DRY DENSITY (pcf)	WATER CONTENT (%)	DEGREE OF SATURATION (%)
AD-3	R-3	18.5-20.0	80.7	37.2	1.088	87.6	34.2	100

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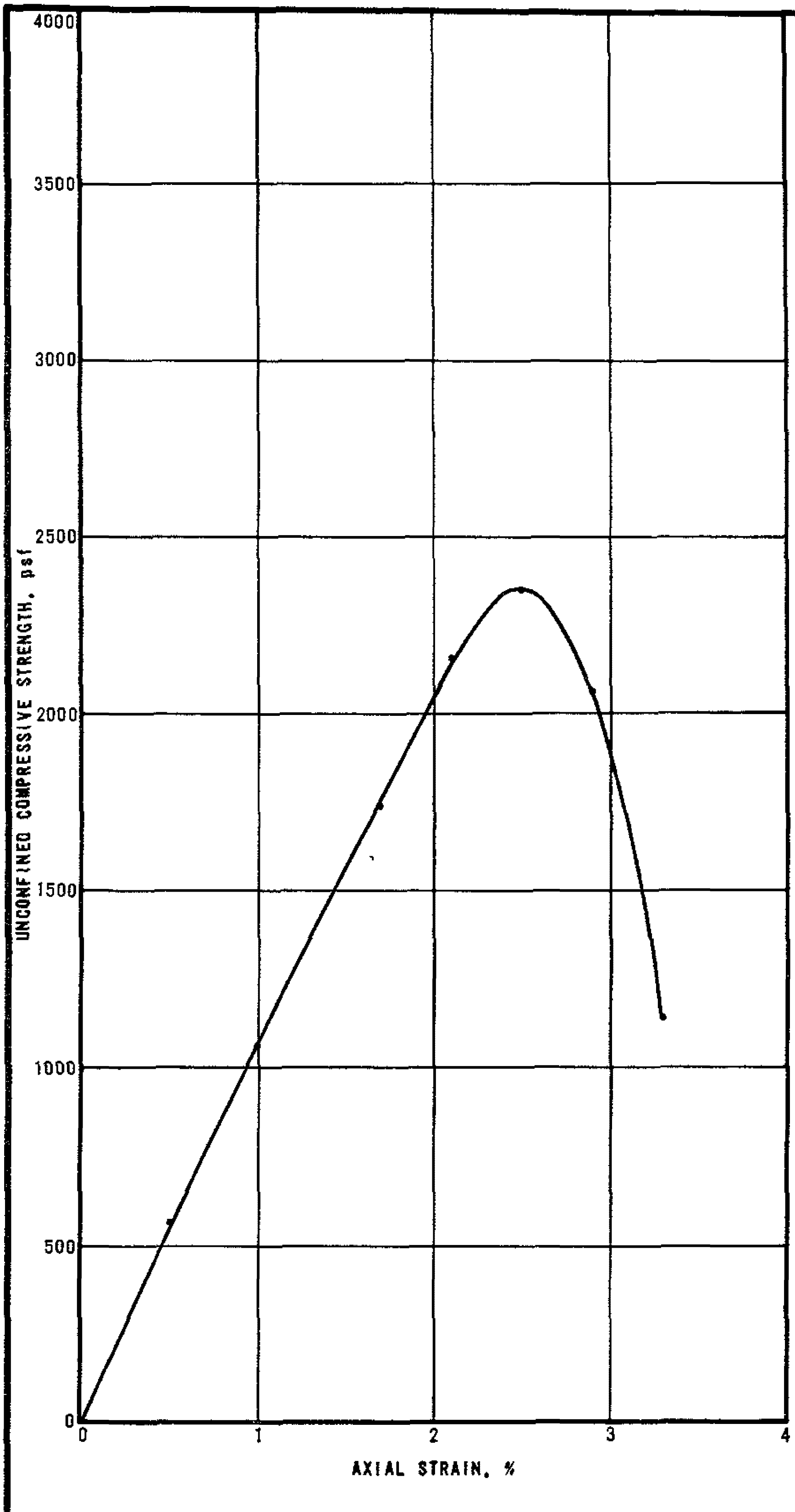
ANDERSON DAM
SPILLWAY ENLARGEMENT

CONSOLIDATION TEST

PROJECT NO.	DATE	FIGURE NO.
SCV-124A	SEPTEMBER 1983	B-27



Hole No.	AD-5		
Sample No.	S-1		
Depth (ft)	8.5-11.0		
Water Cont. %	52.7		
Dry Density, pcf	68.6		
Void Ratio	1.365		
Saturation, %	100		

NOTE: SAMPLE DESCRIPTION:

CLAYEY SAND, YELLOW BROWN

(SERPENTINE)

SEE TABLE 2 FOR OTHER

UNCONFINED TEST RESULTS.

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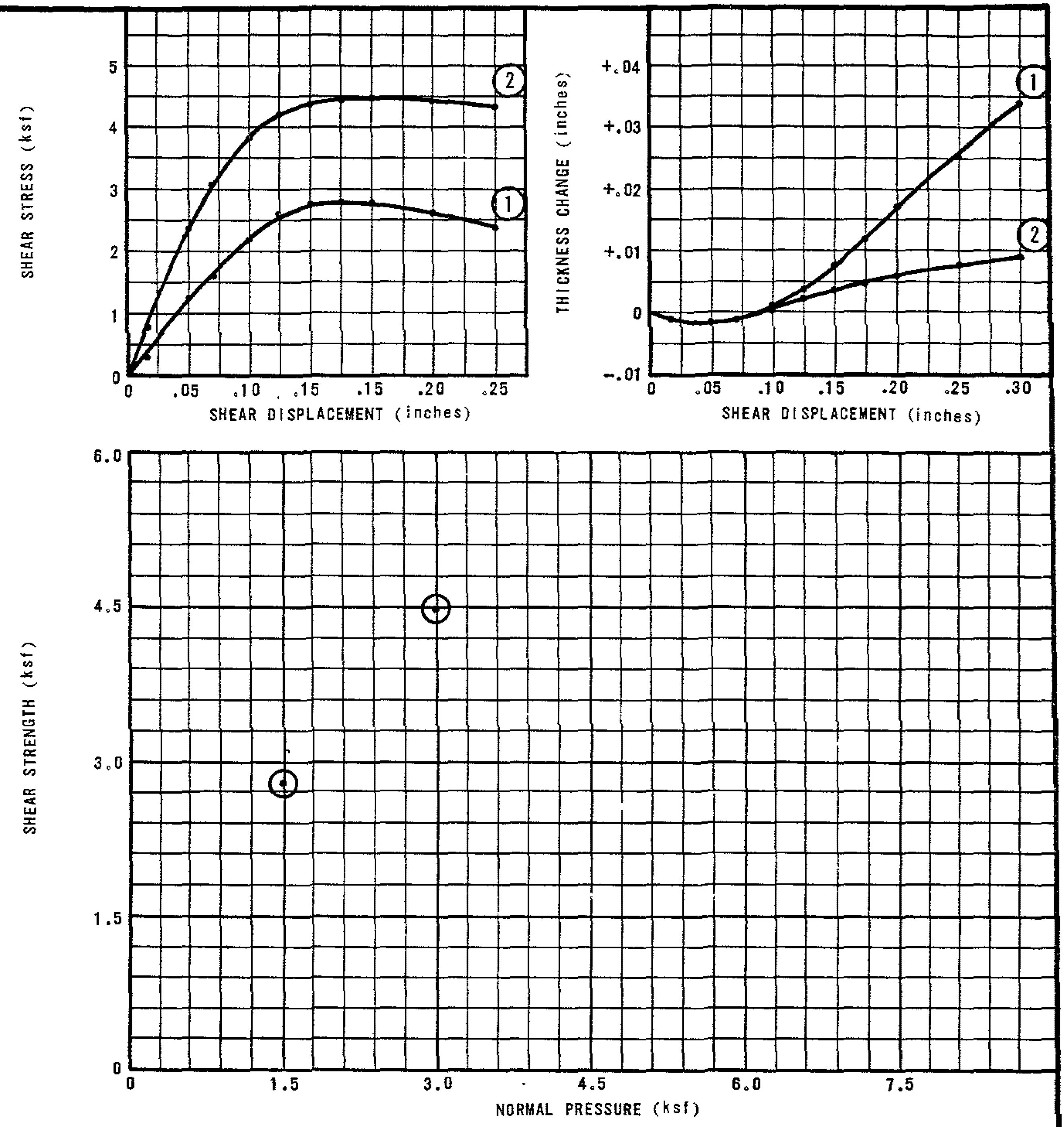
ANDERSON DAM
SPILLWAY ENLARGEMENT

PALO ALTO ● NEWPORT BEACH ● CALIF.

UNCONFINED COMPRESSION TEST

PROJECT NO.	DATE	FIGURE NO.
SCV-124A	SEPTEMBER 1983	B-28



HOLE NO., SAMPLE NO.: AD-1, S-5

DEPTH (ft) 20.5-23.0

SAMPLE DESCRIPTION CLAYEY SAND, BROWN (WITH SANDSTONE)

TEST DESIGNATION CONSOLIDATED, SATURATED, PARTIALLY DRAINED

RATE OF STRAIN 0.025 in/min.

SPECIMEN NUMBER	①	②		
NORMAL PRESSURE (ksf)	1.50	3.00		
SHEAR STRENGTH (ksf)	2.78	4.49		
INITIAL WATER CONTENT (%)	30.3	30.2		
FINAL WATER CONTENT (%)	34.8	33.9		
DRY DENSITY (pcf)	86.9	88.0		

NOTE: CONSOLIDATION PRIOR TO SHEAR: SPEC. #1 = 1.9%
SPEC. #2 = 2.4%

SANDSTONE CHUNK ON THE SHEAR PLANE OF SPEC. #2

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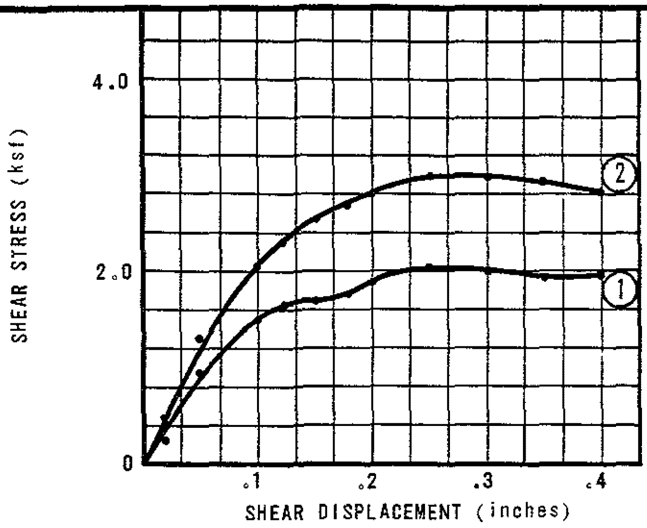
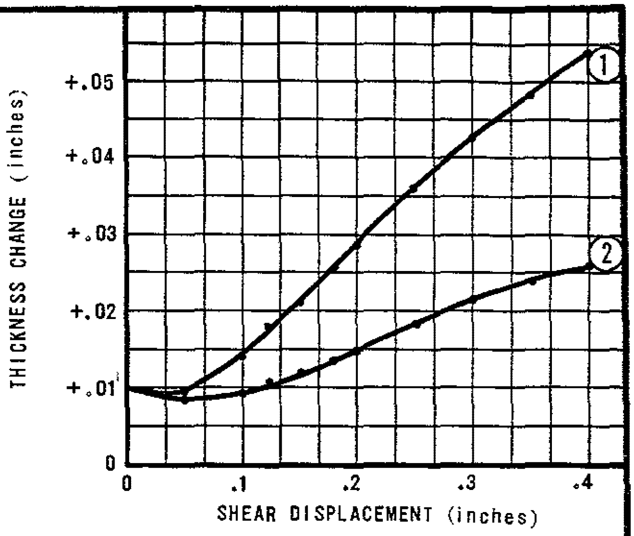
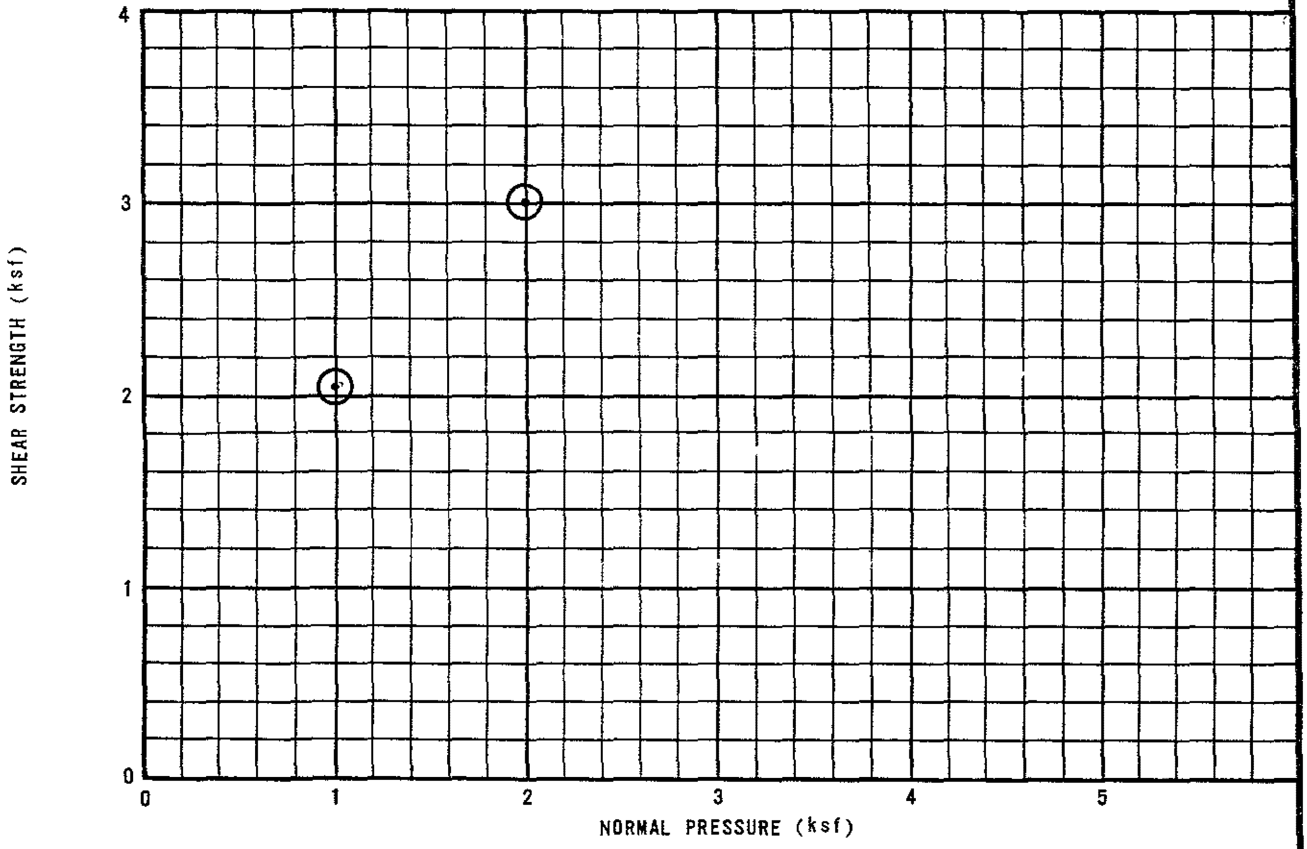
ANDERSON DAM
SPILLWAY ENLARGEMENT

DIRECT SHEAR TEST

PROJECT NO.	DATE	FIGURE NO.
SCV-124A	SEPTEMBER 1983	B-29







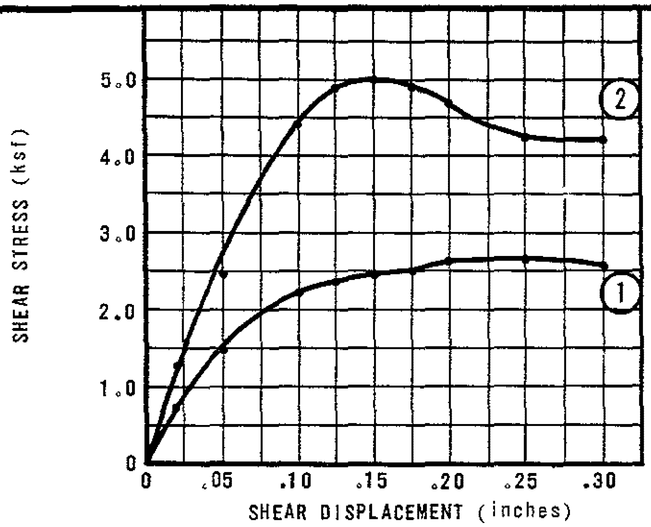
HOLE NO., SAMPLE NO.: AD-2, S-1
DEPTH (ft) 3.0-5.5
SAMPLE DESCRIPTION GRAVELLY SILTY SAND, BROWN (SOME SANDSTONE)
TEST DESIGNATION CONSOLIDATED, SATURATED, PARTIALLY DRAINED
RATE OF STRAIN 0.025 in/min.

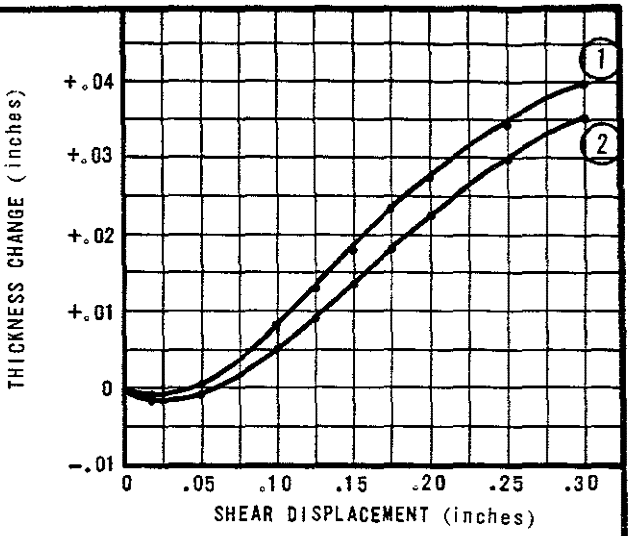
SPECIMEN NUMBER	①	②		
NORMAL PRESSURE (ksf)	1.00	2.00		
SHEAR STRENGTH (ksf)	2.05	3.00		
INITIAL WATER CONTENT (%)	22.4	22.9		
FINAL WATER CONTENT (%)	26.4	27.3		
DRY DENSITY (pcf)	98.3	97.0		

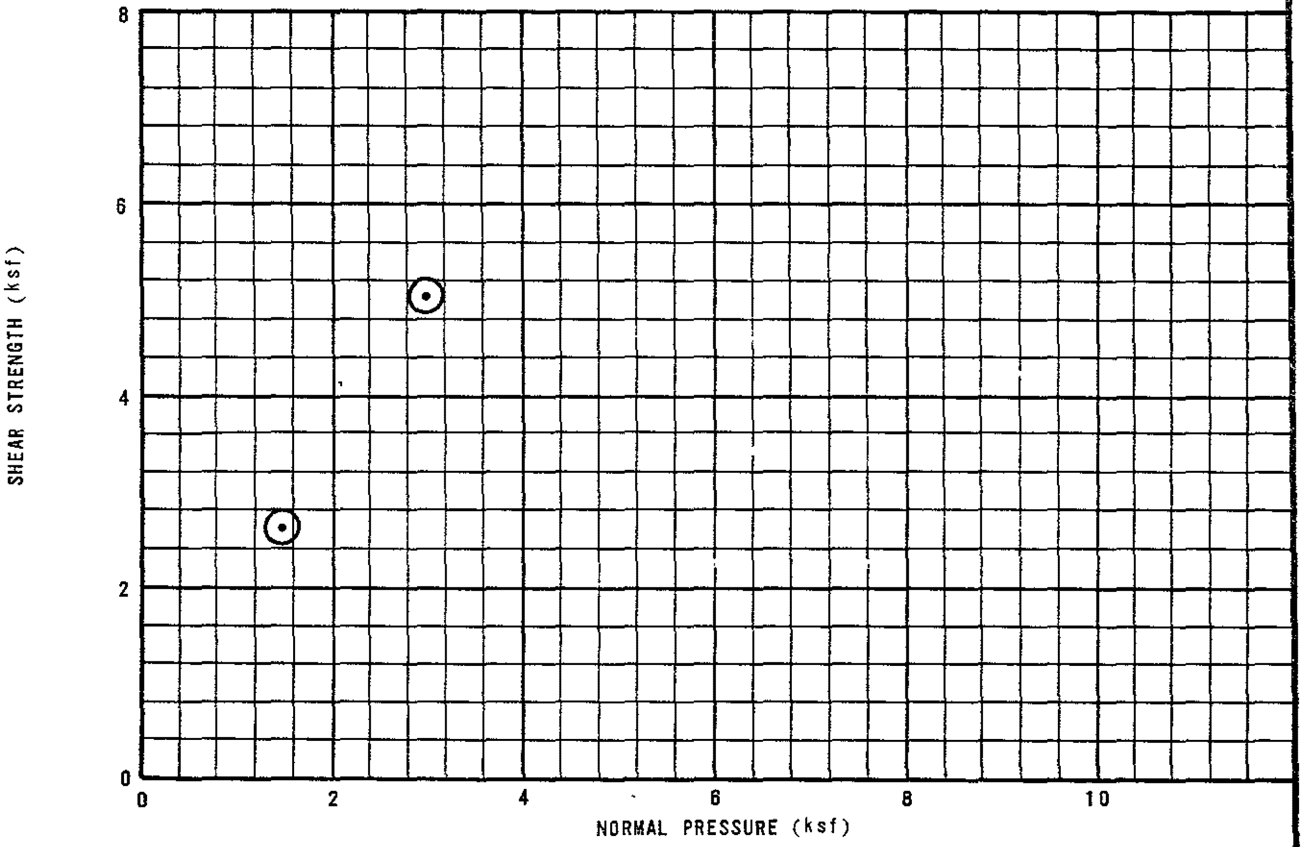
NOTE: CONSOLIDATION PRIOR TO SHEAR: SPEC. #1 = 1.6%
SPEC. #2 = 2.6%

Wahler Associates PALO ALTO • NEWPORT BEACH • CALIF.	ANDERSON DAM SPILLWAY ENLARGEMENT	DIRECT SHEAR TEST	
	PROJECT NO.	DATE	FIGURE NO.
	SCV-124A	SEPTEMBER 1983	B-30

611-2 Rev. 2/69







HOLE NO., SAMPLE NO.: AD-2, R-2

DEPTH (ft) 27.5-29.0

SAMPLE DESCRIPTION GRAVELLY SILTY SAND, GREENISH GRAY (SERPENTINE)

TEST DESIGNATION CONSOLIDATED, SATURATED, PARTIALLY DRAINED

RATE OF STRAIN 0.025 in/min.

SPECIMEN NUMBER	①	②		
NORMAL PRESSURE (ksf)	1.50	3.00		
SHEAR STRENGTH (ksf)	2.63	5.06		
INITIAL WATER CONTENT (%)	26.1	26.0		
FINAL WATER CONTENT (%)	29.5	28.1		
DRY DENSITY (pcf)	91.8	93.7		

NOTE: CONSOLIDATION PRIOR TO SHEAR: SPEC. #1 = 1.3%
SPEC. #2 = 2.3%

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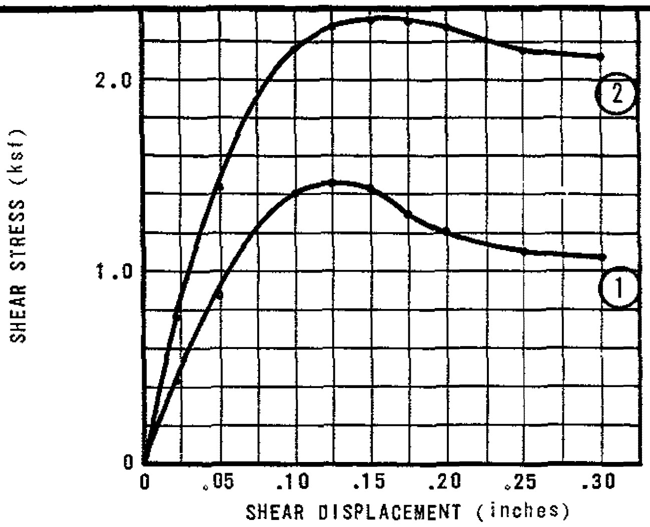
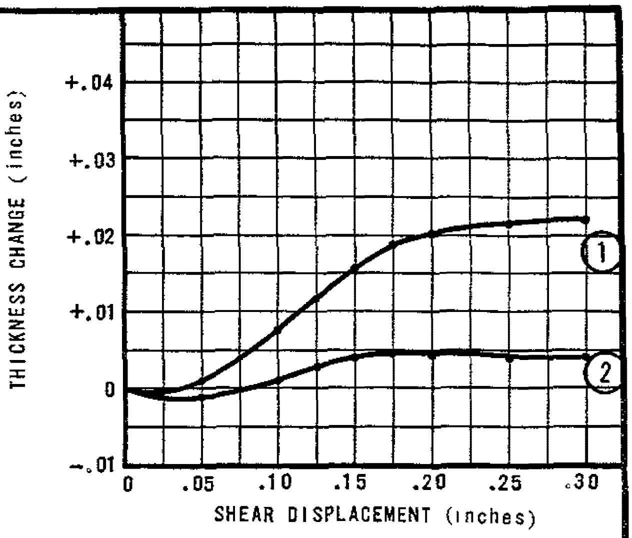
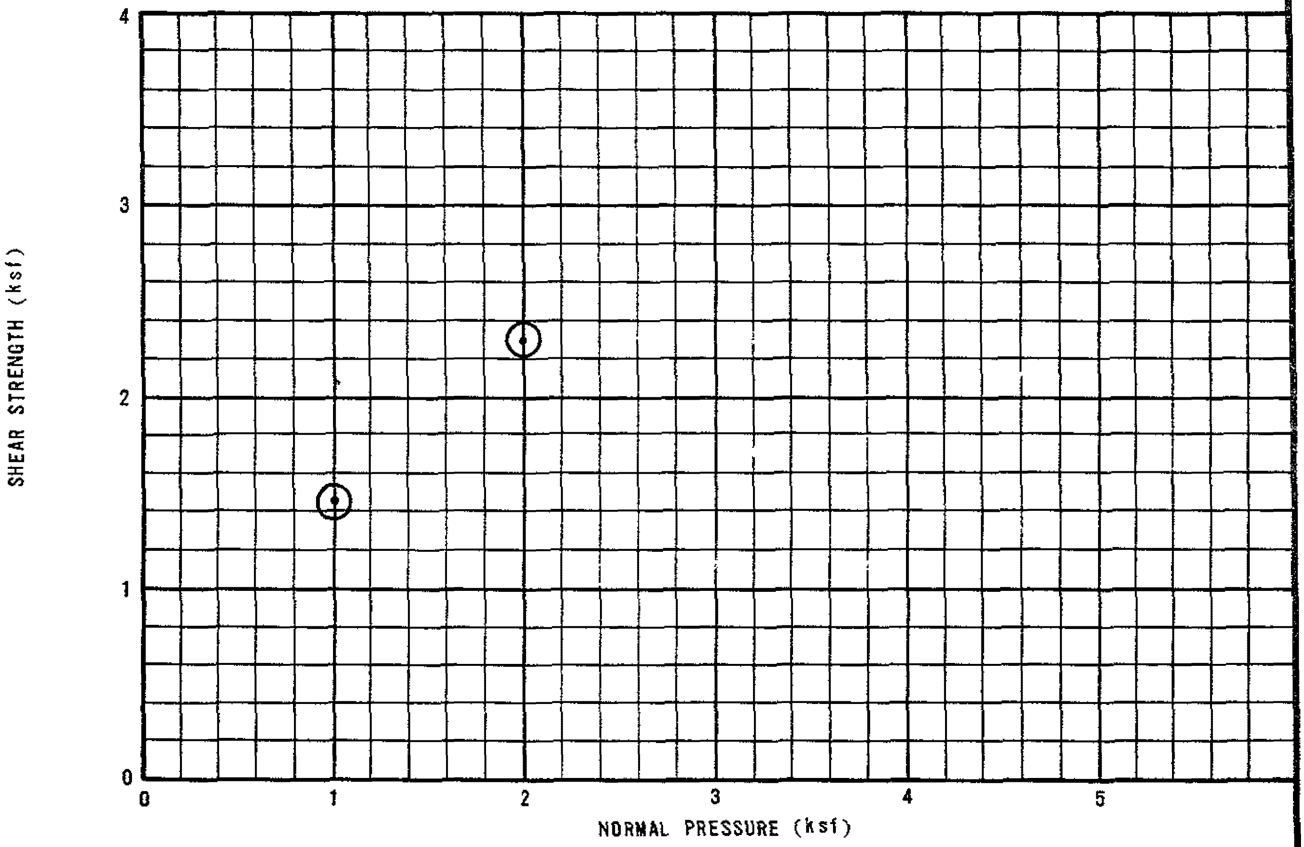
Wahler Associates	ANDERSON DAM SPILLWAY ENLARGEMENT	DIRECT SHEAR TEST
	PALO ALTO • NEWPORT BEACH • CALIF.	PROJECT NO. SCV-124A DATE SEPTEMBER 1983 FIGURE NO. B-31







HOLE NO., SAMPLE NO.: AD-5, R-2
DEPTH (ft) 13.0-14.5
SAMPLE DESCRIPTION GRAVELLY CLAYEY SAND, BROWN
TEST DESIGNATION CONSOLIDATED, SATURATED, PARTIALLY DRAINED
RATE OF STRAIN 0.025 in/min.

SPECIMEN NUMBER	①	②		
NORMAL PRESSURE (ksf)	1.00	2.00		
SHEAR STRENGTH (ksf)	1.46	2.32		
INITIAL WATER CONTENT (%)	19.5	17.2		
FINAL WATER CONTENT (%)	20.4	18.5		
DRY DENSITY (pcf)	108.7	112.4		

NOTE: CONSOLIDATION PRIOR TO SHEAR: SPEC. #1 = 1.0%
SPEC. #2 = 2.0%

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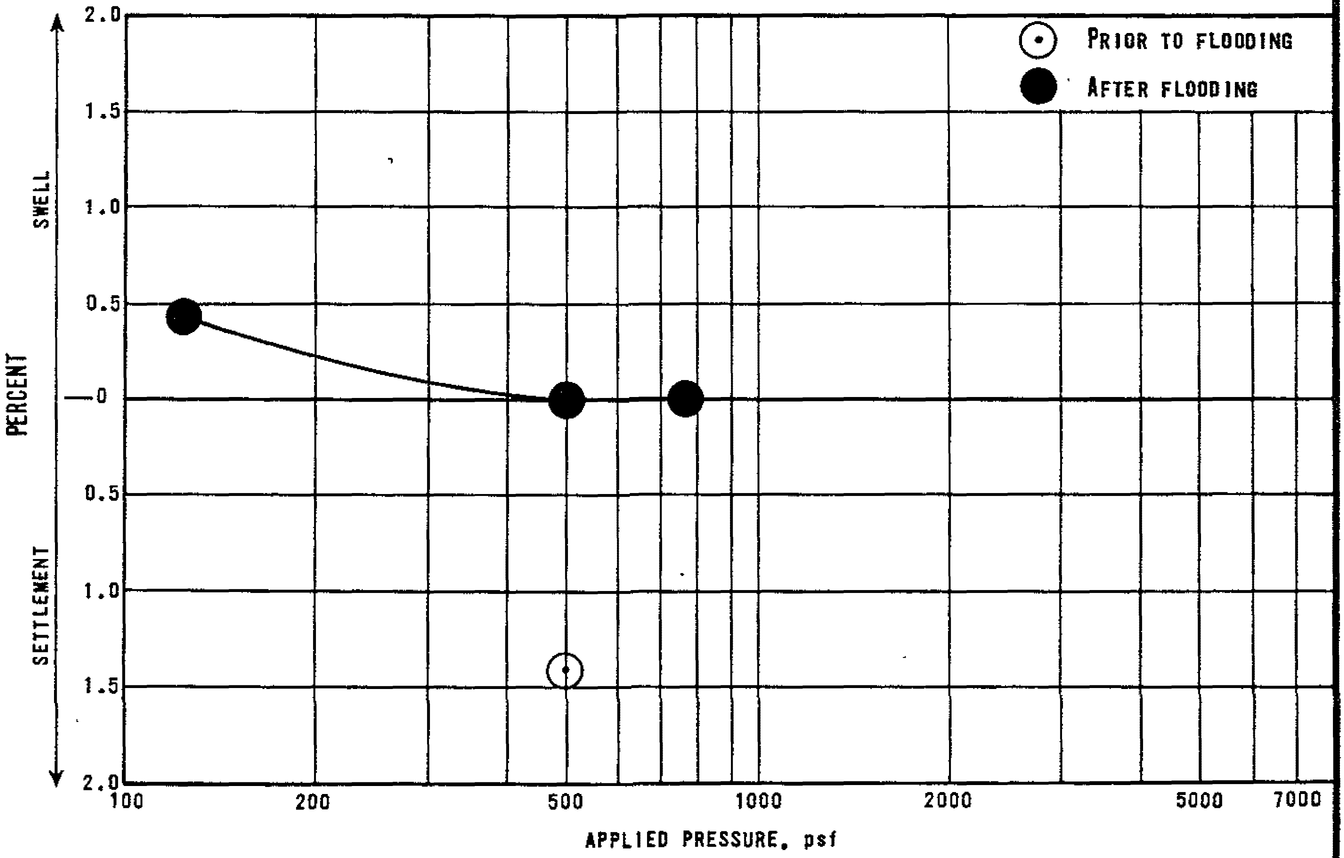
ANDRSON DAM
SPILLWAY ENLARGEMENT

DIRECT SHEAR TEST

PROJECT NO.	DATE	FIGURE NO.
SCV-124A	SEPTEMBER 1983	B-32

HOLE NO.	SAMPLE NO.	DEPTH (ft)	INITIAL SPECIMEN DATA				FINAL SPECIMEN DATA			
			DRY DENSITY (pcf)	WATER CONTENT (%)	VOID RATIO (e)	DEGREE OF SATURATION (%)	DRY DENSITY (pcf)	WATER CONTENT (%)	VOID RATIO (e)	DEGREE OF SATURATION (%)
AD-3	S-1	12.0-15.0	75.7	44.6	1.226	98	76.4	44.0	1.205	99



NOTES: SAMPLE WAS LOADED TO 500 psf AND FLOODED WITH WATER. AFTER FLOODING, SAMPLE WAS LOADED TO 750 psf TO PREVENT SWELLING. SAMPLE WAS THEN UNLOADED TO 500 AND 125 psf AND SWELL MEASURED. PERCENT SWELL IS BASED ON THE HEIGHT OF THE SAMPLE AFTER INITIAL LOAD. FINAL SPECIMEN DATA WERE CALCULATED AT 125 psf.

SAMPLE DESCRIPTION: CLAYEY SANDY SILT, YELLOW BROWN

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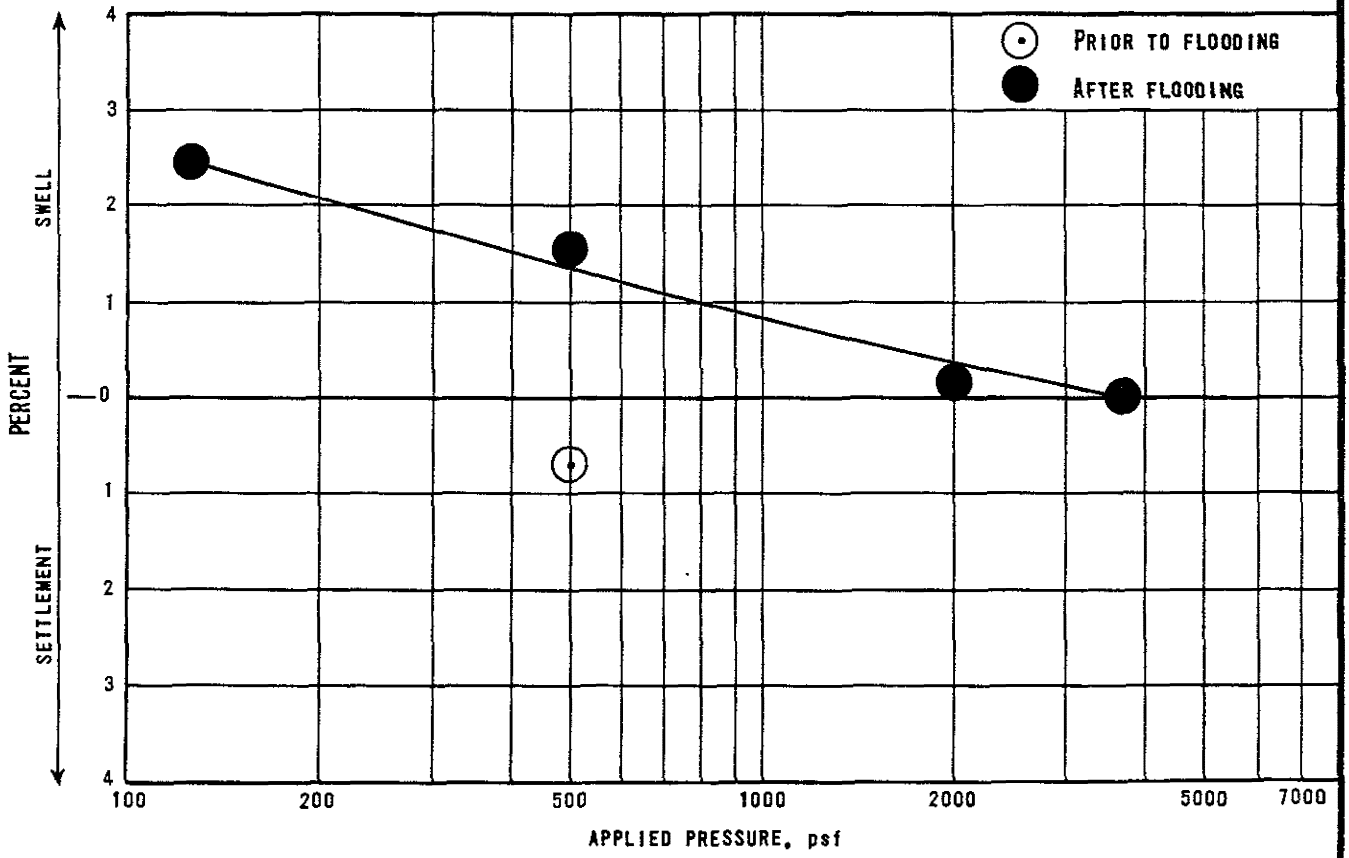
ANDERSON DAM
SIILLWAY ENLARGEMENT

SWELL COMPRESSION TEST

PROJECT NO	DATE	FIGURE NO.
SCV-124A	SEPTEMBER 1983	B-33

HOLE NO.	SAMPLE NO.	DEPTH (ft)	INITIAL SPECIMEN DATA				FINAL SPECIMEN DATA			
			DRY DENSITY (pcf)	WATER CONTENT (%)	VOID RATIO (e)	DEGREE OF SATURATION (%)	DRY DENSITY (pcf)	WATER CONTENT (%)	VOID RATIO (e)	DEGREE OF SATURATION (%)
AD-4	R-1	3.5–5.0	116.3	15.6	0.449	94	114.3	17.6	0.474	100



NOTES: SAMPLE WAS LOADED TO 500 psf AND FLOODED WITH WATER. AFTER FLOODING, SAMPLE WAS INCREMENTALLY LOADED TO 3500 psf TO PREVENT SWELLING. SAMPLE WAS THEN UNLOADED TO 2000, 500, AND 125 psf AND SWELL MEASURED. PERCENT SWELL IS BASED ON THE HEIGHT OF THE SAMPLE AFTER INITIAL LOAD. FINAL SPECIMEN DATA WERE CALCULATED AT 125 psf.

SAMPLE DESCRIPTION: GRAVELLY SANDY CLAY, BROWN

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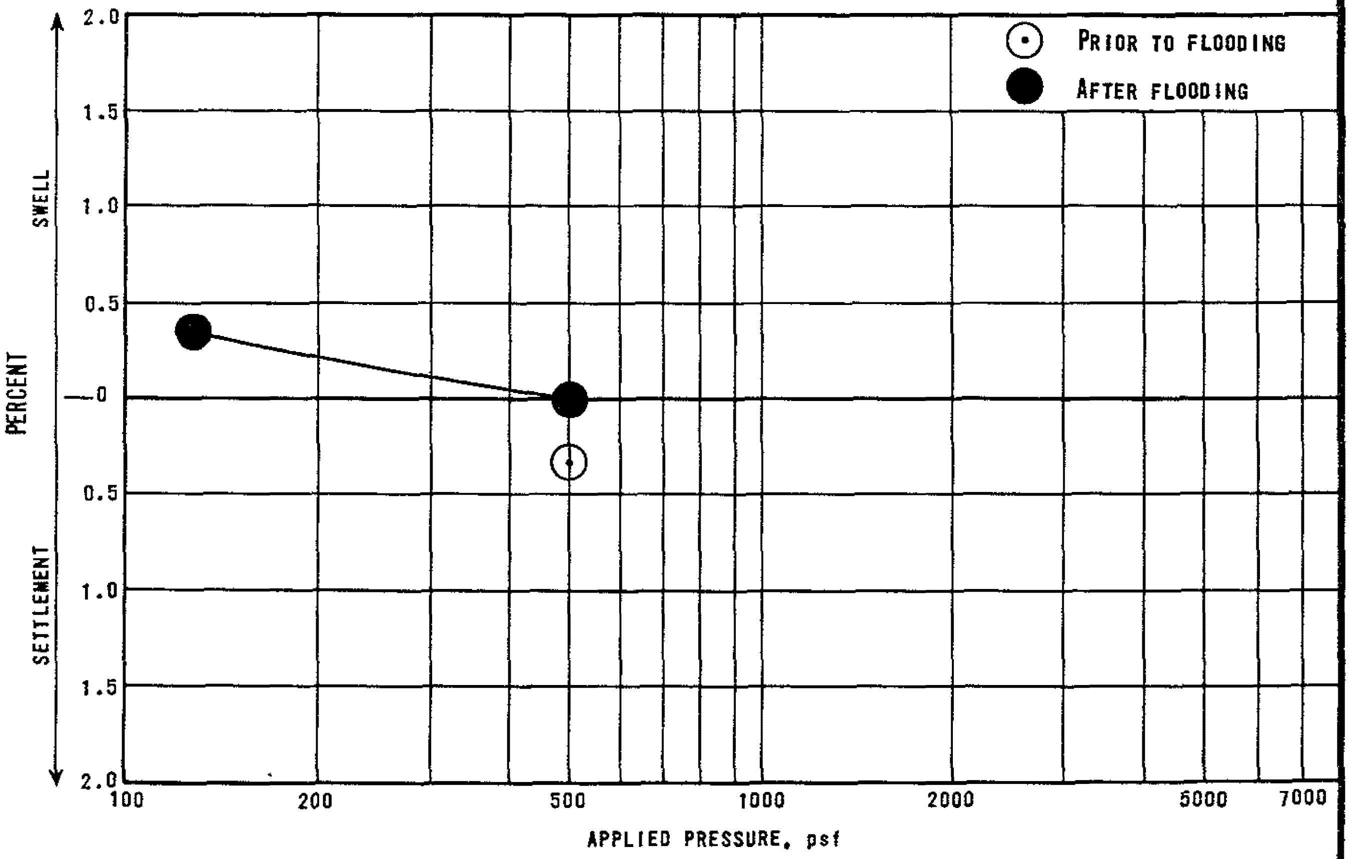
ANDERSON DAM
SPILLWAY ENLARGEMENT

SWELL COMPRESSION TEST

PROJECT NO	DATE	FIGURE NO.
SCV-124A	SEPTEMBER 1983	B-34

HOLE NO.	SAMPLE NO.	DEPTH (ft)	INITIAL SPECIMEN DATA				FINAL SPECIMEN DATA			
			DRY DENSITY (pcf)	WATER CONTENT (%)	VOID RATIO (e)	DEGREE OF SATURATION (%)	DRY DENSITY (pcf)	WATER CONTENT (%)	VOID RATIO (e)	DEGREE OF SATURATION (%)
AD-4	R-2	13.0-14.5	111.7	17.8	0.508	95	111.7	18.3	0.508	97



NOTES: SAMPLE WAS LOADED TO 500 psf AND FLOODED WITH WATER. NO SWELL WAS RECORDED. SAMPLE WAS THEN UNLOADED TO 125 psf AND SWELL MEASURED. PERCENT SWELL IS BASED ON THE HEIGHT OF THE SAMPLE AFTER INITIAL LOAD. FINAL SPECIMEN DATA WERE CALCULATED AT 125 psf.

SAMPLE DESCRIPTION: SILTY CLAYEY SAND, YELLOW BROWN

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ANDERSON DAM
SPILLWAY ENLARGEMENT

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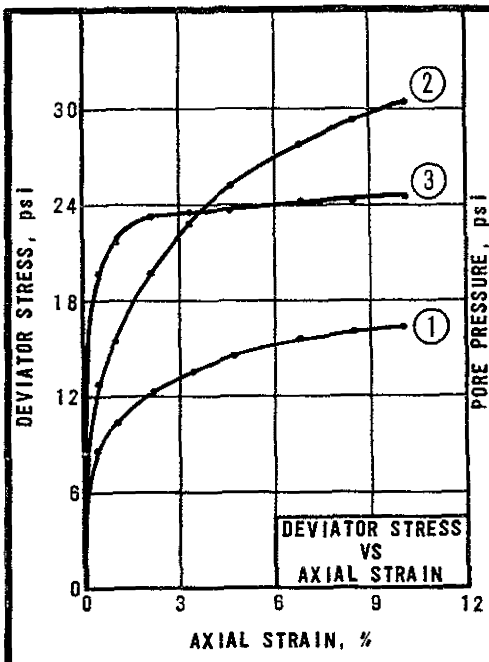
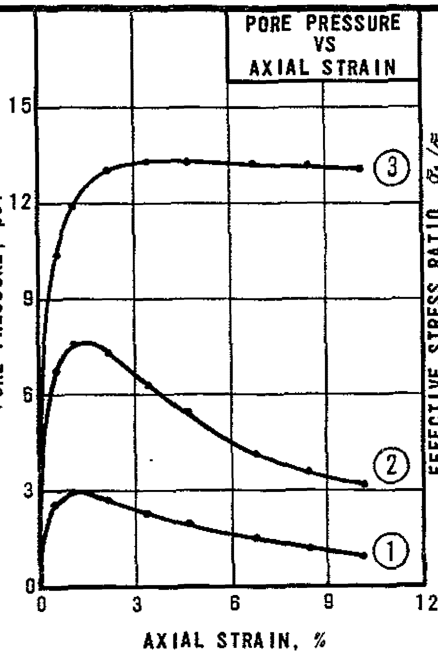
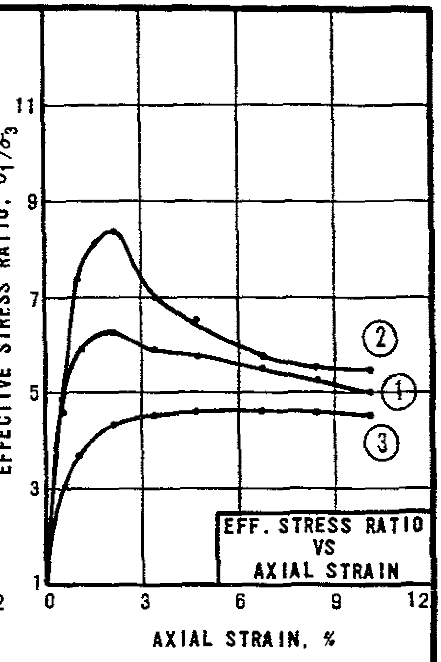
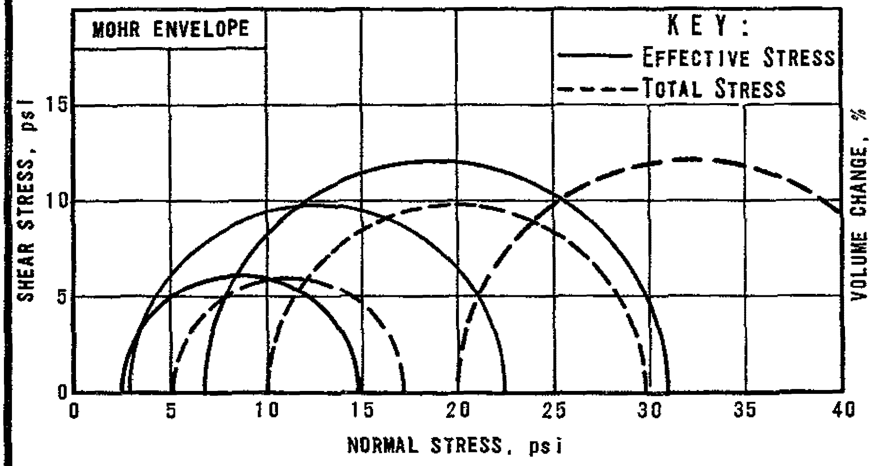
SWELL COMPRESSION TEST

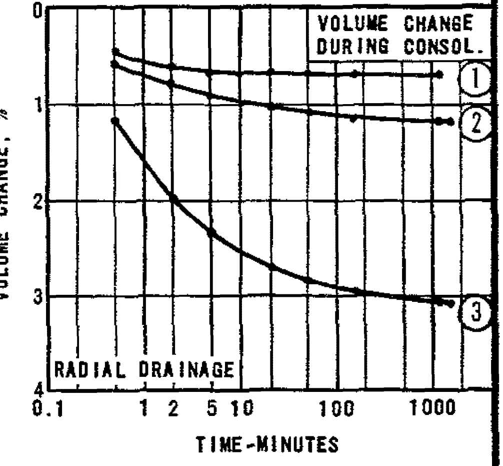
PROJECT NO	DATE	FIGURE NO.
SCV-124A	SEPTEMBER 1983	B-35



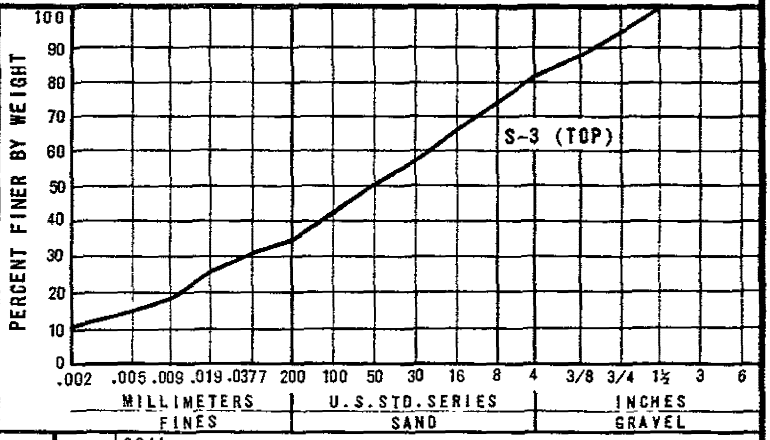








SPECIMEN NO.		①	②	③
INITIAL CONDITION	Water Content,%	37.4	20.1	33.9
	Opt.Water Content,%	----	----	----
	Dry Density,pcf	80.7	107.8*	83.0
	Max.Dry Density,pcf	----	----	----
	Void Ratio	1.089	0.563	1.032
	Saturation,%	93.0	96.5	88.9
FINAL CONDITION	Consol.Pressure,psi	5.0	10.0	20.0
	Water Content,%	39.7	20.2	35.9
	Dry Density, pcf	81.3	109.1	85.6
	Void Ratio	1.074	0.544	0.969
	Saturation,%	100	100	100
GENERAL	Specimen Diameter.in	2.875	2.875	2.875
	Back Pressure,psi	50.0	50.0	50.0
	Test Time,hr	2.42	2.42	2.42
	Rate of Strain,%/hr	4.15	4.16	4.20



SYMB	SM	SOIL CLASSIFICATION GRAVELLY SILTY SAND, HIGH PLASTIC,
LL	64	RED BROWN
PL	39	SAMPLE LOCATION SPEC. NO. 1 & 2: AD-1, S-3, 12.5'-15.0'
PI	25	SPEC. NO. 3: AD-1, S-4, 17.5'-20.0'
SG	2.7	NOTE: UNDISTURBED SPECIMENS.
	(est)	*LARGE ROCK INSIDE SPECIMEN

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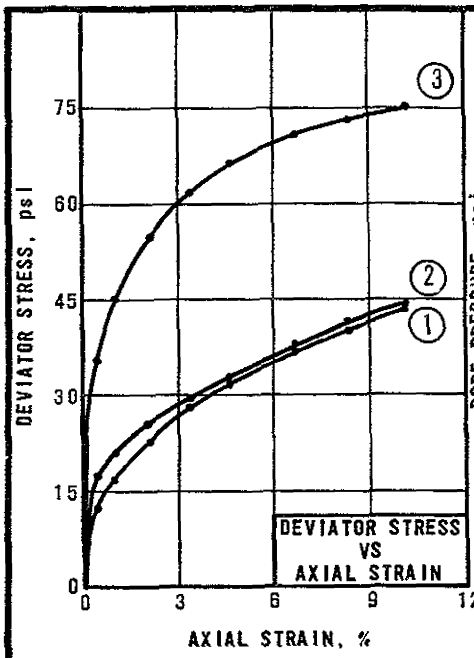
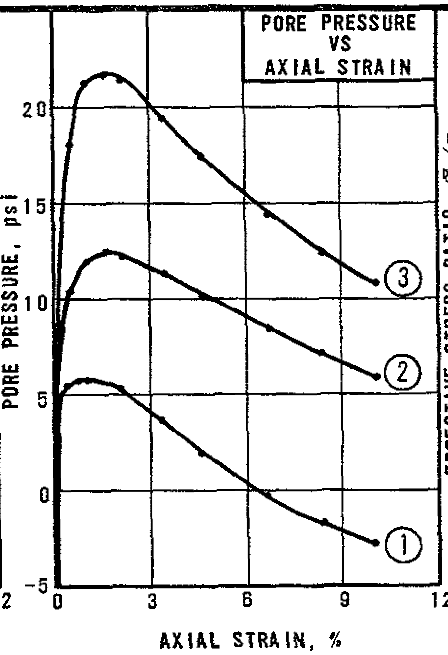
SPILLWAY ENLARGEMENT

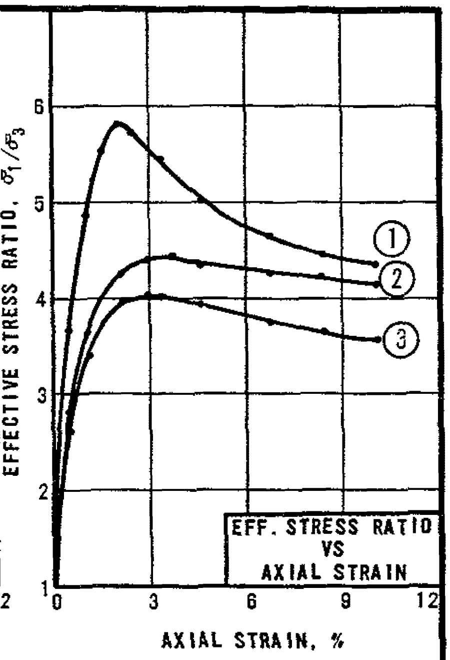
TRIAXIAL TEST RESULTS
CONSOLIDATED UNDRAINED

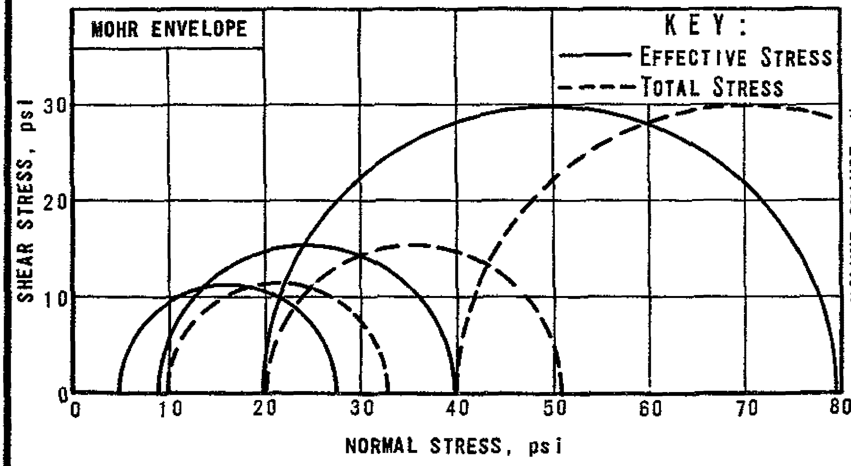
PROJECT NO.	DATE	FIGURE NO.
SCV-124A	SEPTEMBER 1983	B-36

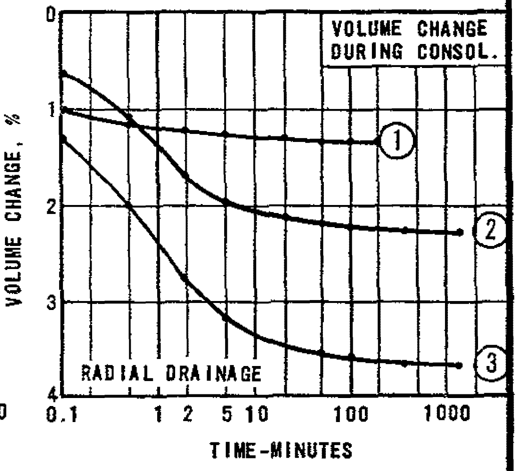
HOLE NO., SAMPLE NO.
AD-1, S-3 & 4



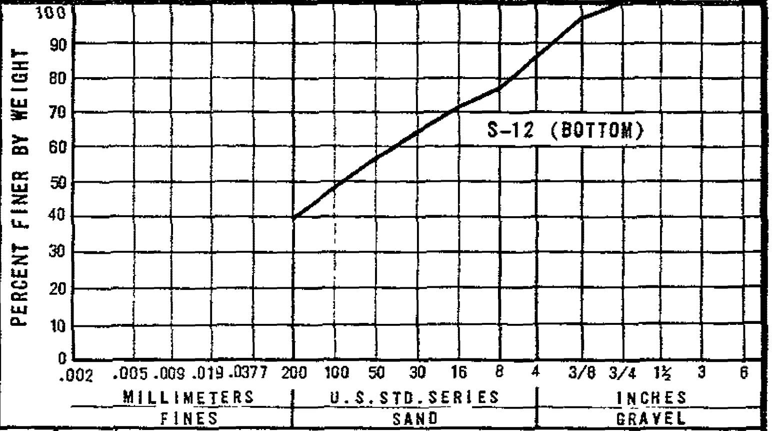








	SPECIMEN NO.	①	②	③
INITIAL CONDITION	Water Content,%	27.7	27.3	23.4
	Opt.Water Content,%	----	----	----
	Dry Density,pcf	93.3	94.8	98.4
	Max.Dry Density,pcf	----	----	----
	Void Ratio	0.807	0.777	0.713
	Saturation,%	93.0	94.9	88.6
FINAL CONDITION	Consol.Pressure,psi	10.0	20.0	40.0
	Water Content,%	28.9	27.3	24.1
	Dry Density, pcf	94.6	97.1	102.1
	Void Ratio	0.782	0.736	0.650
	Saturation,%	100	100	100
GENERAL	Specimen Diameter,in	2.875	2.875	2.875
	Back Pressure,psi	50.0	50.0	50.0
	Test Time,hr	2.68	2.68	2.68
	Rate of Strain,%/hr	3.75	3.77	3.80



SYMB	SM	SOIL CLASSIFICATION GRAVELLY SILTY SAND, PLASTIC,
LL	----	YELLOW BROWN WITH GREEN
PL	----	SAMPLE LOCATION SPEC. NO.1: AD-1, S-11, 35.0'-37.5'
PI	----	SPEC. NO. 2 & 3: AD-1, S-12, 37.5'-40.0'
SG	2.7 (est)	NOTE: UNDISTURBED SPECIMENS

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ANDERSON DAM
SPILLWAY ENLARGEMENT

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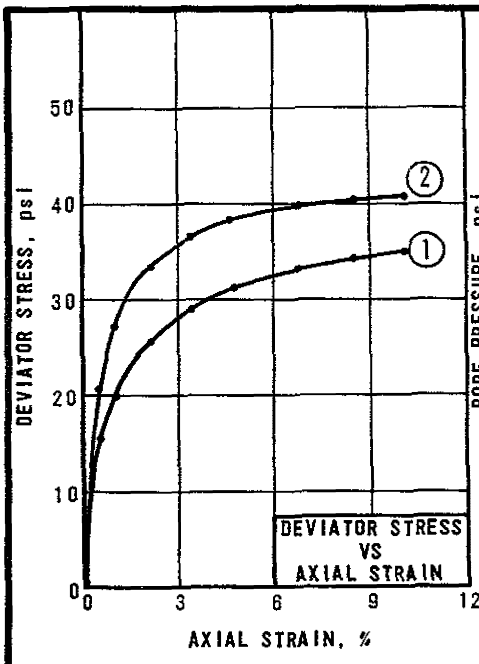
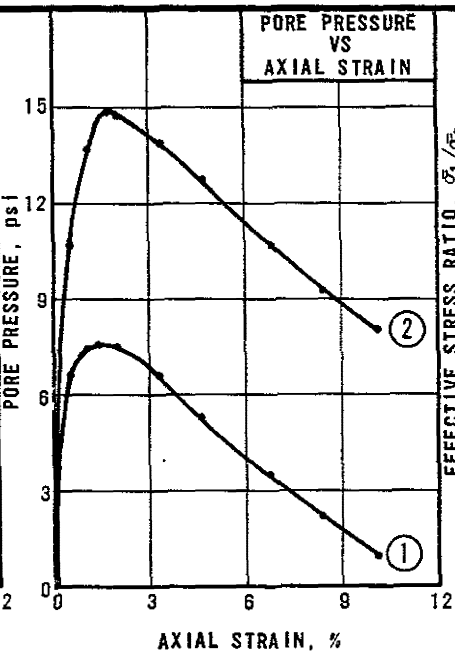
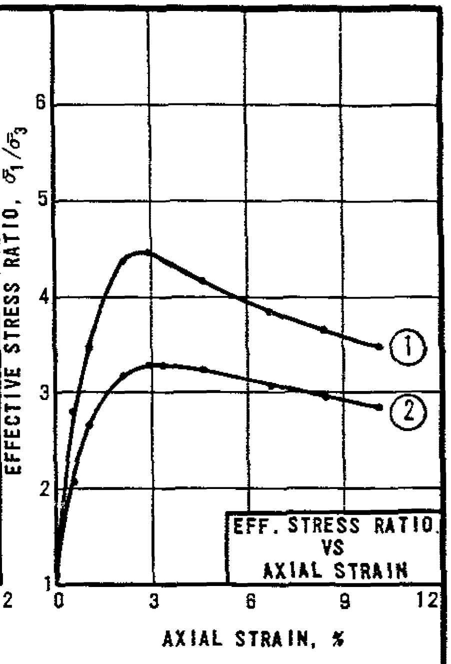
TRIAXIAL TEST RESULTS
CONSOLIDATED UNDRAINED

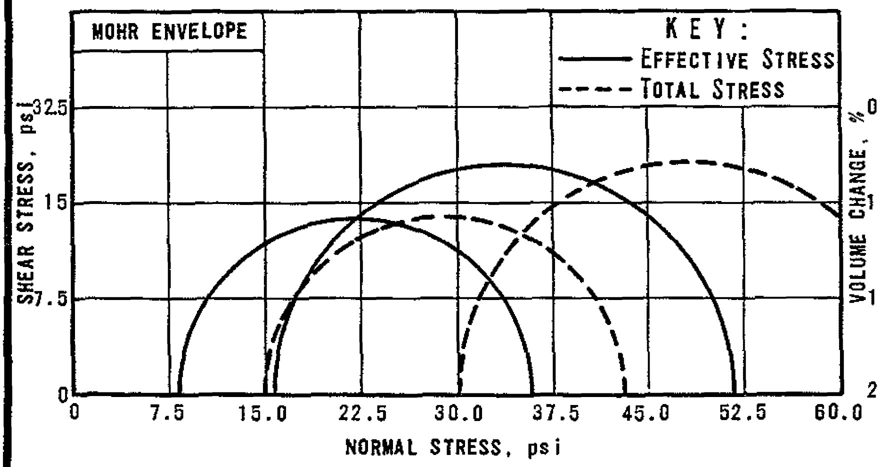
PROJECT NO.	DATE	FIGURE NO.
SCV-124A	OCTOBER 1983	B-37

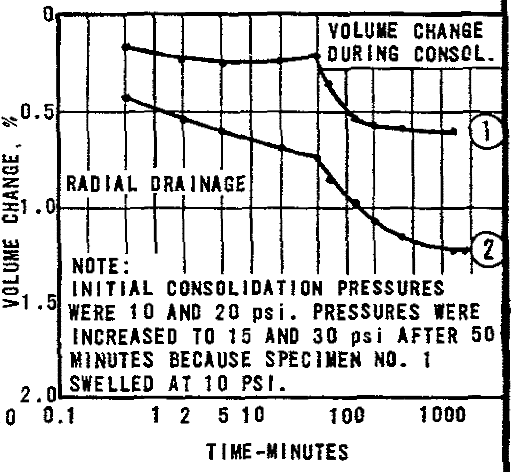
HOLE NO., SAMPLE NO.
AD-1, S-11 & 12





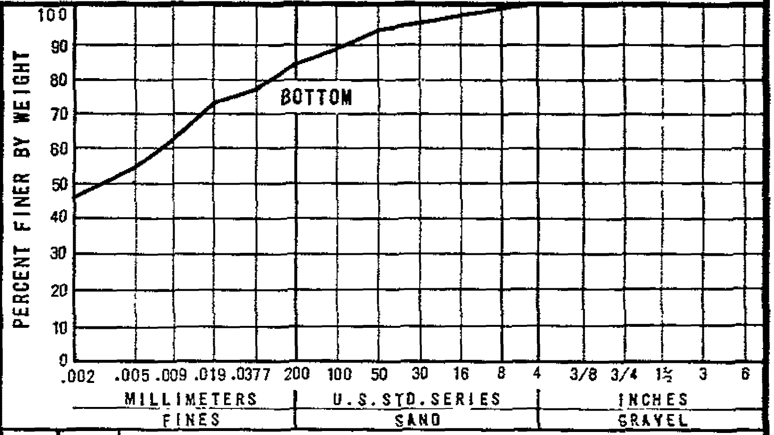






NOTE: INITIAL CONSOLIDATION PRESSURES WERE 10 AND 20 psi. PRESSURES WERE INCREASED TO 15 AND 30 psi AFTER 50 MINUTES BECAUSE SPECIMEN NO. 1 SWELLED AT 10 PSI.

	SPECIMEN NO.	①	②
INITIAL CONDITION	Water Content,%	18.7	21.1
	Opt.Water Content,%	----	----
	Dry Density,pcf	109.8	106.5
	Max.Dry Density,pcf	----	----
	Void Ratio	0.534	0.582
	Saturation,%	94.9	97.9
FINAL CONDITION	Consol.Pressure,psi	15.0	30.0
	Water Content,%	19.4	20.8
	Dry Density, pcf	110.5	107.8
	Void Ratio	0.525	0.563
	Saturation,%	100	100
GENERAL	Specimen Diameter,in	2.875	2.875
	Back Pressure,psi	50.0	50.0
	Test Time,hr	2.70	2.70
	Rate of Strain,%/hr	3.71	3.73



SYMB	CH	SOIL CLASSIFICATION SANDY CLAY, YELLOW RED BROWN
LL	----	
PL	----	SAMPLE LOCATION AD-6, S-1, 10.0'-12.3'
PI	----	
SG	2.7 (est)	NOTE: UNDISTURBED SPECIMENS. SPECIMEN NO. 2 EXHIBITED SHEAR FAILURE

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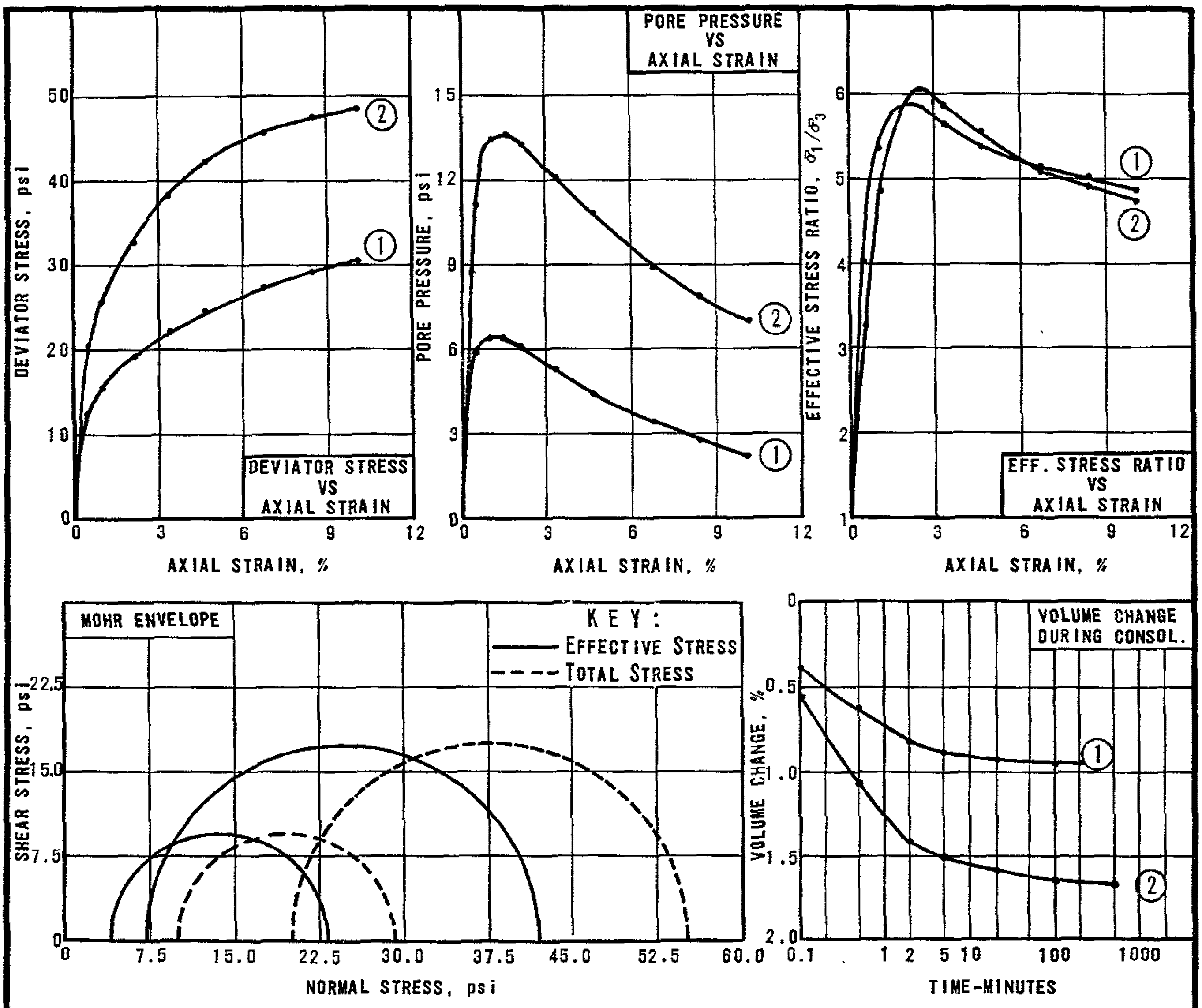
ANDERSON DAM
SPILLWAY ENLARGEMENT

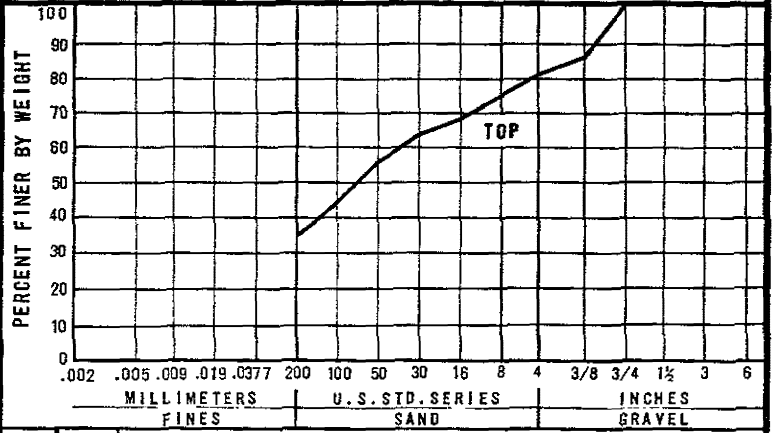
TRIAXIAL TEST RESULTS
CONSOLIDATED UNDRAINED

PROJECT NO.	DATE	FIGURE NO.
SCV-124A	OCTOBER 1983	B-38

HOLE NO., SAMPLE NO.
AD-6, S-1



	SPECIMEN NO.	①	②
INITIAL CONDITION	Water Content,%	25.9	26.4
	Opt.Water Content,%	----	----
	Dry Density,pcf	97.3	95.1
	Max.Dry Density,pcf	----	----
	Void Ratio	0.732	0.773
	Saturation,%	95.7	92.5
FINAL CONDITION	Consol.Pressure,psi	10.0	20.0
	Water Content,%	26.4	27.5
	Dry Density, pcf	98.3	96.7
	Void Ratio	0.715	0.743
	Saturation,%	100	100
GENERAL	Specimen Diameter.in	2.875	2.875
	Back Pressure,psi	50.0	50.0
	Test Time,hr	2.68	2.68
	Rate of Strain,%/hr	3.74	3.76



SYMB	SM	SOIL CLASSIFICATION GRAVELLY SILTY SAND, PLASTIC,
LL	----	RED BROWN WITH GREEN
PL	----	SAMPLE LOCATION AD-8, S-1, 13.0'-15.5'
PI	----	
SG	2.7 (est)	NOTE: UNDISTURBED SPECIMENS

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ANDERSON DAM
SPILLWAY ENLARGEMENT

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TRIAXIAL TEST RESULTS
CONSOLIDATED UNDRAINED

PROJECT NO.	DATE	FIGURE NO.
SCV-124A	OCTOBER 1983	B-39

HOLE NO., SAMPLE NO.
AD-8, S-1

APPENDIX C

ROY J. SHLEMON & ASSOC., INC.
Geological and Environmental Consultants

Post Office Box 3066
Newport Beach, California
U.S.A. 92663
Tel: (714) 675-2696

Quaternary Geology
Economic Geomorphology
Soil Stratigraphy
Geoarchaeology

3 August 1983

Mr. David K. Gill, Water Supply Manager
Santa Clara Valley Water District
5750 Almaden Expressway
San Jose, California 95118

Dear Mr. Gill:

Please find enclosed two copies of a report entitled "Age of Faulting, Anderson Dam and Spillway Geotechnical Investigations, Santa Clara County, California."

The report briefly spells out the geomorphic and soil-stratigraphic evidence and conclusions concerning the probably age of faults exposed in trenches and in the spillway area of the Anderson Dam, as observed during our reconnaissance of 29 July 1983.

I thank you again for the many courtesies; and would appreciate it very much if you might pass along my thanks and regards to Bob Tepel and your colleagues at the Santa Clara Valley Water District for all the logistical support.

Should there be any questions, please advise.

Sincerely,

Roy J. Shlemon, Ph.D.

RJS: qgg

cc: E. Solomon, Waller Associates ✓
w/enc.

ROY J. SHLEMON & ASSOC., INC.
Geological and Environmental Consultants

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Newport Beach, California
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Quaternary Geology
Economic Geomorphology
Soil Stratigraphy
Geoarchaeology

3 August 1983

AGE OF FAULTING, ANDERSON DAM AND SPILLWAY GEOTECHNICAL INVESTIGATIONS, SANTA CLARA COUNTY, CALIFORNIA

INTRODUCTION

This report summarizes results of a geomorphic and soil-stratigraphic reconnaissance to assess the age of faults, possibly part of the Coyote Creek system, exposed near the right abutment and spillway of the Anderson Dam in Santa Clara County, California. The investigation was commissioned by the Santa Clara Valley Water District (SCVWD) and carried out on 29 July 1983. Field observers were D. Gill and R. Tepel (SCVWD); E. Solomon and A. Buangan (Waller Associates, Palo Alto); and G. Hanegan (Calif. Dept. Dam Safety, Sacramento).

Logistical support was provided by the SCVWD and Waller Associates (WA). Particularly appreciated were the background commentary and documentation (mainly maps and trench logs) made available by Robert E. Tepel (SCVWD) and Ernest Solomon (WA). The conclusions noted in this report summarize those spelled out in the field with all geotechnical personnel concerned. Locations of critical exposures and relevant trenches are shown on various maps now in preparation by WA.

DATA SOURCES

In addition to field observations, the geomorphic-soil reconnaissance benefited greatly from previous mapping and the on-going investigations carried out by Waller Associates. The various maps and trench logs examined and, where appropriate, referred to in this summary as "data sources" are:

1. Dibblee, T. W., 1973a, Preliminary geologic map of the Morgan Hill quadrangle, Santa Clara County, California: U.S. Geol. Survey Open-file map, scale 1:24,000.
2. _____, 1973b, Preliminary geologic map of the Mt. Sizer quadrangle, Santa Clara County, California: U.S. Geol. Survey Open-file map, scale 1:24,000.
3. Waller Associates, 1983, Preliminary log, Trench T-8: log of portion of cut slope; dated 6/22/83, scale 1" = 5.'
4. _____, 1983, Preliminary log, Trench T-9: log of portion of vertical cut; undated, scale 1" = 5.'
5. (Author unknown), 1949, Anderson Dam General Plan (topographic map with geological notation, pre-construction) for Santa Clara Valley Water District, scale 1" = 180' (partial photocopy reproduction).
6. General location maps of Waller Associates trenches and geological observation sites (identified, for example, as "location 8-1" and "location 8-2.")

GEOMORPHIC/SOIL-STRATIGRAPHIC OBSERVATIONS

Trench T-9 (Shoreline area):

(1) Significant shears and fractures, some with gouge, are well exposed, mainly between stations 0+2 and 0+20 (WA trench log). Clearly displaced is Fransciscan-age serpentine. And old alluvial unit, with Fransciscan lithologies, deemed "Qtl," is locally incorporated in

shear zones, but is not displaced by some shears elsewhere, indicative of probable multiple movements in this area.

(2) A younger, overlying alluvial deposit with clasts to six inches diameter, is designated "Qt2" (WA trench log). This deposit ranges in thickness from zero to somewhat in excess of three feet. As exposed near station 0+18, the basal section of the unit is displaced about nine inches (reverse sense).

(3) Overlying Qt2 is approximately 15 ft of overbank and minor channel deposits typified by subrounded pebbles and a few cobbles. From reconnaissance observations this unit is undisplaced, and therefore post-dates all shears exposed in T-9. A minimal age for these deposits is ascertained mainly by weathering characteristics (soil profile characteristics) and geomorphic position.

(4) The post-Qt2 deposits (notation 3 above) are highly weathered and bear a reddish brown (colors in Munsell notation), and moderately- to strongly-developed soil (pedological) profile. As observed near station 0+6, the soil is about 4.5 ft thick with argillic horizon (B2t; pebbly loam; strong, coarse angular blocky structure; 7.5YR matrix; and 5YR 3/3 thick, continuous clay films lining ped faces and filling interstitial pores and root tubules). Except for the effect of modern bioturbation and organic matter, this soil has the characteristi of a relict paleosol; that is, it formed mainly under weathering envir ments of the past, but is still in whole or part preserved at the surf

Studies of nearby terrane with comparable soil climate and parent mate lithology and grain-size show that relict paleosols similar to that at

Trench 9 are, at a minimum, about 100,000 years old (Shlemon, 1979, 1980, 1982), forming mainly during marine oxygen isotope stage 5 (Shackleton and Opdyke, 1973, 1976; Bloom and others, 1974). The deposits on which this soil has formed are inherently older. Accordingly, from soil-stratigraphic evidence, last displacement of faults exposed in T-9 must have taken place at least 100,000 years ago and conceivably well before that time.

(5) Geomorphic evidence likewise suggests that the undisplaced deposits are in the order of at least "tens of thousands of years" old. As shown on pre-construction maps (data source 5), "old terrace gravels" had been previously mapped in the area of present Trench 9. These gravels were shown to be at least 150 ft above the modern Coyote Creek floodplain. In addition, the gravels are similar in lithology and stratigraphic position to those described as typical of the early Quaternary Santa Clara Formation (Dibblee, 1973a; data source 1). Further, the gravels are exposed discontinuously "downstream" from T-9, particularly along the right (north) side of the Anderson Dam spillway, attesting to their deposition as an extensive fluvial terrace deposits, rather than as a restricted colluvium. Owing to their continuity and high elevation above the floodplain, from a geomorphic standpoint, these old, undisplaced gravels were therefore likely laid down under a fluvial environment substantially different from the present; one seemingly controlled by climatic fluctuations during the Quaternary, and at a minimum occurring "tens" rather than a few thousand years ago.

Spillway Area (Waller Associates Location 8-1):

The sediments exposed here are mainly mud- and debris-flows overlying Franciscan "bedrock." The deposits are dissimilar to the bouldery gravels (Qt2) shown displaced at Trench 9. At Location 8-1, the debris-flow characteristics are mainly a heterogeneous accumulation of very angular clasts to 3-in long diameter derived from Franciscan assemblages, and a yellowish-brown (7.5YR 4/4) silty clay matrix. Additionally, reddish-brown (5YR) clay films line ped faces and fill very fine root tubules, attesting to an age of the debris-flows here in excess of at least several thousand years. No evidence for faulting is observed at this locality.

Spillway Area (Waller Associated Location 8-2):

A fault here displaces basal terrace gravels similar in size and lithology to WA unit Qt2 at T-9. Observed offset here is about 1.5 ft vertical. Overlying units are covered at this locality, and the fault apparently parallels, rather than intersects, the slope in this locality. However, post-Qt2 sediments, similar to those undisplaced in T-9, crop out immediately "upstream" from this locality, and from reconnaissance overlie projections of the fault. This area will be examined and logged to ascert more clearly the extent and age of faulting (Waller Associates).

SUMMARY OF CONCLUSIONS

1. Shears and faults, possibly part of the Coyote Creek fault system, are expo in WA Trench 9. The faults displace Franciscan-age serpentine and an old gravel (Qt1). Stratigraphic relations indicate probable multiple movement rather than "single event" offset in this area.

2. An overlying, bouldery alluvial deposit (Qt2) is also displaced along at least one shear with an observed reverse sense of displacement of approximately 9 inches.

3. All shears in T-9 are overlain by approximately 15 ft of overbank and channel gravels, the age of which is ascertained by geomorphic and soil-stratigraphic evidence. From soil profile characteristics, the undisplaced sediments are in the order of at least 100,000 years old. From geomorphic position and elevation above the modern drainage, the sediments are likewise judged to be some "tens of thousands" of years old.

4. The undisplaced deposits may in part be coeval with the Santa Clara Formation as mapped by Dibblee (1973a) in this area.

5. Sediments exposed at Waller Associates Location 8-1 are mainly of debris-flow origin, and are unrelated in genesis to the fluvial terrace and overbank deposits exposed in T-9. They were laid down over, rather than tectonically emplaced into, the underlying Franciscan deposits.

6. From geomorphic and soil-stratigraphic reconnaissance, last displacement of those segments of the Coyote Creek Fault, as exposed in Trench 9 and cuts adjacent to the right abutment and spillway of Anderson Dam, took place at least 100,000 years ago, and conceivably well before that time.

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(excluding "data sources" indicated in text, p. 2)

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_____, 1976, Oxygen isotope and paleomagnetic stratigraphy of Pacific core V28-239, late Pliocene to latest Pleistocene: Geol. Soc. America Memoir 145, p. 449-464.

Shlemon, R. J., 1979, Late Quaternary soil stratigraphy, General Electric Test Reactor site, Vallecitos Nuclear Center, Alameda County, California: in Geologic investigation, Phase II: for Earth Sciences Associates (Palo Alto) on behalf of General Electric Company, Appendix A, p. 1-43.

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EXPLANATION

GEOLOGIC UNITS

QUATERNARY DEPOSITS

Qf	FILL: SILTY SAND, CLAYEY SAND LARGELY DERIVED FROM SERPENTINE, SOME GRAYWACKE, EXCEPT EMBANKMENT; LIGHT TO DARK GRAY
Qal	ALLUVIUM: SAND, GRAVEL, COBBLES
Qsw	SLOPEWASH: UNDIFFERENTIATED
Qsw_r	CLAYEY SAND, RED BROWN, LOCALIZED THIN DEPOSITS ON STEEP SLOPES
Qsw_b	CLAY, DARK BROWN-BLACK, ACCUMULATED IN GENTLY SLOPING LOW AREAS
Qt	TERRACE DEPOSIT: COMMONLY CLAYEY SAND, SANDY CLAY, SOMETIMES GRAVELLY, UNDIFFERENTIATED OLDER COLLUVIAL AND ALLUVIAL DEPOSITS; OFTEN RED BROWN
Qt_1	SANDY GRAVEL WITH COBBLES; FRANCISCAN DETRITUS; UNCEMENTED; OLDER ALLUVIUM; GRAY
Qt_2	CLAYEY SANDY GRAVEL WITH COBBLES, BOULDERS; FRANCISCAN DETRITUS; CEMENTED IN SOME HORIZONS, ESP. LOWER IN SECTION; OLDER ALLUVIUM AND COLLUVIUM; RED BROWN

MESOZOIC DEPOSITS
FRANCISCAN COMPLEX

gw	GRAYWACKE: DARK GRAY TO GRAY, FRESH; TAN, WEATHERED; INTENSELY FRACTURED TO MASSIVE; FINE GRAINED; WELL CEMENTED; STRONG EXCEPT WHERE SHEARED OR WEATHERED
gr	GREENSTONE: DUSKY GREEN TO RED BROWN; METAIGNEOUS ROCK; HARD, MODERATELY FRACTURED
sh	SHALE: DARK GRAY TO BLACK; DISCONTINUOUS; COMMONLY SHEARED, CRUSHED

ULTRABASIC INTRUSIVE

sp	SERPENTINE: LIGHT TO DARK GREEN, SOME TAN OR YELLOW; COMMONLY CRUSHED AND OR SHEARED, ALTERED; UNDIFFERENTIATED
sp_1	SERPENTINE YELLOW WITH SOME GRAY; CRUSHED SOIL-LIKE, WITH FEW COBBLES TO BOULDER SIZE PIECES OF HARD SERPENTINE; WEAK FRIABLE
sp_2	SERPENTINE: HARD; BLOCKY; CLOSELY TO MODERATELY FRACTURED
sp_3	SERPENTINE: HARD, BLOCKY, COBBLE SIZE PIECES OF SERPENTINE IN SHEARED, CRUSHED, GRAY, SOIL-LIKE SERPENTINE MATRIX
sp_4	SERPENTINE: VARIES INTENSELY FRACTURED TO CRUSHED; SHEARED APPEARANCE; APPEARS ROCK-LIKE WHEN DRY; SOIL-LIKE WHEN WET; WEAK, FRIABLE; SLICKENSIDES COMMON; LIGHT BLUE GRAY AND DARK GRAY

GEOLOGIC SYMBOLS

——?——?·····	GEOLOGIC CONTACT, DASHED WHERE INFERRED, DOTTED WHERE COVERED OR BURIED, QUERIED WHERE DOUBTFUL
63	STRIKE AND DIP OF BEDDING
56	GEOLOGIC CONTACT SHOWING DIP
40 65	STRIKE AND DIP OF JOINT
76	SHEAR ZONE SHOWING DIP
	SEEP

EXPLORATION SYMBOLS

AD-1 ⊕	EXPLORATION HOLE
T-1	EXPLORATION TRENCH
SL-1	SEISMIC REFRACTION LINE
T-8	AREA OF STEEP SLOPE LOGGED AS AN EXPLORATION TRENCH; SEE APPENDIX A FOR LOG
A A	GEOLOGIC SECTION; SEE FIGURE III-3

SCALE
20 0 20 FEET

Wahler Associates

ANDERSON DAM SPILLWAY ENLARGEMENT

PALO ALTO • NEWPORT BEACH • CALIF.

GEOLOGY AND EXPLORATION APPROACH CHANNEL

PROJECT NO.	DATE	FIGURE NO.
SCV-124A	NOVEMBER 1983	III-1

EXPLANATION

GEOLOGIC UNITS

QUATERNARY DEPOSITS

Qf	FILL: SILTY SAND, CLAYEY SAND LARGELY DERIVED FROM SERPENTINE, SOME GRAYWACKE, LIGHT TO DARK GRAY
Qal	ALLUVIUM: SAND, GRAVEL, COBBLES
Qsw	SLOPEWASH: UNDIFFERENTIATED
Qsw_r	CLAYEY SAND, RED BROWN, LOCALIZED THIN DEPOSITS ON STEEP SLOPES, INCLUDES LOCAL LANDSLIDE
Qsw_b	CLAY, DARK BROWN-BLACK, ACCUMULATED IN GENTLY SLOPING LOW AREAS
Qt	TERRACE DEPOSIT: COMMONLY CLAYEY SAND, SANDY CLAY, SOMETIMES GRAVELLY UNDIFFERENTIATED OLDER COLLUVIAL AND ALLUVIAL DEPOSITS; OFTEN RED BROWN.
Qt_1	SANDY GRAVEL WITH COBBLES; FRANCISCAN DETRITUS; UNCEMENTED; OLDER ALLUVIUM; GRAY
Qt_2	CLAYEY SANDY GRAVEL WITH COBBLES, BOULDERS; FRANCISCAN DETRITUS; CEMENTED IN SOME HORIZONS, ESP. LOWER IN SECTION; OLDER ALLUVIUM AND COLLUVIUM; RED BROWN

MESOZOIC DEPOSITS
FRANCISCAN COMPLEX

gw	GRAYWACKE: DARK GRAY TO GRAY, FRESH; TAN, WEATHERED; INTENSELY FRACTURED TO MASSIVE; FINE GRAINED; WELL CEMENTED; STRONG EXCEPT WHERE SHEARED OR WEATHERED.
gr	GREENSTONE: DUSKY GREEN TO RED BROWN; METAIGNEOUS ROCK; HARD, MODERATELY FRACTURED.
sh	SHALE: DARK GRAY TO BLACK; DISCONTINUOUS; COMMONLY SHEARED, CRUSHED

ULTRABASIC INTRUSIVE

sp	SERPENTINE: LIGHT TO DARK GREEN, SOME TAN OR YELLOW; COMMONLY CRUSHED AND/OR SHEARED, ALTERED.

GEOLOGIC SYMBOLS

—?— —?······	GEOLOGIC CONTACT, DASHED WHERE INFERRED, DOTTED WHERE BURIED, QUERIED WHERE DOUBTFUL
35	STRIKE AND DIP OF BEDDING
——┴——	GEOLOGIC CONTACT SHOWING DIP
65 35	STRIKE AND DIP OF JOINT
65	SHEAR ZONE SHOWING DIP
♀	SEEP

EXPLORATION SYMBOLS

AD-5 ⊕	EXPLORATION HOLE
T-20	EXPLORATION TRENCH
TP-19	TEST PIT
SL-1	SEISMIC REFRACTION LINE
7-3 5-2 •	CONCRETE CORE HOLE
8-1 ⑧	FIELD NOTES
E E	GEOLOGIC SECTION

NOTES:

1. GEOLOGIC SECTIONS SHOWN ON FIGURES III-3 TO III-11
2. GEOLOGY AND EXPLORATION OF APPROACH CHANNEL SHOWN ON FIGURE III-1

SCALE

50 0 50 FEET

Wahler Associates

ANDERSON DAM
SPILLWAY ENLARGEMENT

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GEOLOGY AND EXPLORATION
SPILLWAY CHANNEL

PROJECT NO.	DATE	FIGURE NO.
SCV-124A	NOVEMBER 1983	III-2

EXPLANATION

GEOLOGIC UNITS

QUATERNARY DEPOSITS

Qf	FILL: SILTY SAND, CLAYEY SAND LARGELY DERIVED FROM SERPENTINE, SOME GRAYWACKE, EXCEPT EMBANKMENT; LIGHT TO DARK GRAY
Qal	ALLUVIUM: SAND, GRAVEL, COBBLES
Qsw	SLOPEWASH: UNDIFFERENTIATED
Qsw_r	CLAYEY SAND, RED BROWN, LOCALIZED THIN DEPOSITS ON STEEP SLOPES
Qsw_b	CLAY, DARK BROWN-BLACK, ACCUMULATED IN GENTLY SLOPING LOW AREAS
Qt	TERRACE DEPOSIT: COMMONLY CLAYEY SAND, SANDY CLAY, SOMETIMES GRAVELLY, UNDIFFERENTIATED OLDER COLLUVIAL AND ALLUVIAL DEPOSITS; OFTEN RED BROWN
Qt_1	SANDY GRAVEL WITH COBBLES; FRANCISCAN DETRITUS; UNCEMENTED; OLDER ALLUVIUM; GRAY
Qt_2	CLAYEY SANDY GRAVEL WITH COBBLES, BOULDERS; FRANCISCAN DETRITUS; CEMENTED IN SOME HORIZONS, ESP. LOWER IN SECTION; OLDER ALLUVIUM AND COLLUVIUM; RED BROWN

MESOZOIC DEPOSITS
FRANCISCAN COMPLEX

gw	GRAYWACKE: DARK GRAY TO GRAY, FRESH; TAN, WEATHERED; INTENSELY FRACTURED TO MASSIVE; FINE GRAINED; WELL CEMENTED; STRONG EXCEPT WHERE SHEARED OR WEATHERED
gr	GREENSTONE: DUSKY GREEN TO RED BROWN; METAIGNEOUS ROCK; HARD, MODERATELY FRACTURED
sh	SHALE: DARK GRAY TO BLACK; DISCONTINUOUS; COMMONLY SHEARED, CRUSHED

ULTRABASIC INTRUSIVE

sp	SERPENTINE: LIGHT TO DARK GREEN, SOME TAN OR YELLOW; COMMONLY CRUSHED AND OR SHEARED, ALTERED; UNDIFFERENTIATED
sp_1	SERPENTINE: YELLOW WITH SOME GRAY; CRUSHED SOIL-LIKE, WITH FEW COBBLES TO BOULDER SIZE PIECES OF HARD SERPENTINE; WEAK FRIABLE
sp_2	SERPENTINE: HARD; BLOCKY; CLOSELY TO MODERATELY FRACTURED
sp_3	SERPENTINE: HARD, BLOCKY, COBBLE SIZE PIECES OF SERPENTINE IN SHEARED, CRUSHED, GRAY, SOIL-LIKE SERPENTINE MATRIX
sp_4	SERPENTINE: VARIES INTENSELY FRACTURED TO CRUSHED; SHEARED APPEARANCE, APPEARS ROCK-LIKE WHEN DRY; SOIL-LIKE WHEN WET; WEAK, FRIABLE; SLICKENSIDES COMMON; LIGHT BLUE GRAY AND DARK GRAY

GEOLOGIC SYMBOLS

——?— —?.....	GEOLOGIC CONTACT, DASHED WHERE INFERRED, DOTTED WHERE COVERED OR BURIED, QUERIED WHERE DOUBTFUL
63	STRIKE AND DIP OF BEDDING
56	GEOLOGIC CONTACT SHOWING DIP
40 ✕ 65	STRIKE AND DIP OF JOINT
76	SHEAR ZONE SHOWING DIP
	SEEP

EXPLORATION SYMBOLS

AD-1 ⊕	EXPLORATION HOLE
T-1	EXPLORATION TRENCH
SL-1	SEISMIC REFRACTION LINE
T-8	AREA OF STEEP SLOPE LOGGED AS AN EXPLORATION TRENCH; SEE APPENDIX A FOR LOG
A A	GEOLOGIC SECTION; SEE FIGURE III-3

SCALE

20 0 20 FEET

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ANDERSON DAM SPILLWAY ENLARGEMENT

GEOLOGY AND EXPLORATION APPROACH CHANNEL

PROJECT NO.	DATE	FIGURE NO.
SCV-124A	NOVEMBER 1983	III-1

EXPLANATION

GEOLOGIC UNITS

QUATERNARY DEPOSITS

Qf	FILL: SILTY SAND, CLAYEY SAND LARGELY DERIVED FROM SERPENTINE, SOME GRAYWACKE, LIGHT TO DARK GRAY
Qal	ALLUVIUM: SAND, GRAVEL, COBBLES
Qsw	SLOPEWASH: UNDIFFERENTIATED
Qsw_r	CLAYEY SAND, RED BROWN, LOCALIZED THIN DEPOSITS ON STEEP SLOPES, INCLUDES LOCAL LANDSLIDE
Qsw_b	CLAY, DARK BROWN-BLACK, ACCUMULATED IN GENTLY SLOPING LOW AREAS
Qt	TERRACE DEPOSIT: COMMONLY CLAYEY SAND, SANDY CLAY, SOMETIMES GRAVELLY UNDIFFERENTIATED OLDER COLLUVIAL AND ALLUVIAL DEPOSITS; OFTEN RED BROWN.
Qt_1	SANDY GRAVEL WITH COBBLES; FRANCISCAN DETRITUS; UNCEMENTED; OLDER ALLUVIUM; GRAY
Qt_2	CLAYEY SANDY GRAVEL WITH COBBLES, BOULDERS; FRANCISCAN DETRITUS; CEMENTED IN SOME HORIZONS, ESP. LOWER IN SECTION; OLDER ALLUVIUM AND COLLUVIUM; RED BROWN

MESOZOIC DEPOSITS
FRANCISCAN COMPLEX

gw	GRAYWACKE: DARK GRAY TO GRAY, FRESH; TAN, WEATHERED; INTENSELY FRACTURED TO MASSIVE; FINE GRAINED; WELL CEMENTED; STRONG EXCEPT WHERE SHEARED OR WEATHERED.
gr	GREENSTONE: DUSKY GREEN TO RED BROWN; METAIGNEOUS ROCK; HARD, MODERATELY FRACTURED.
sh	SHALE: DARK GRAY TO BLACK; DISCONTINUOUS; COMMONLY SHEARED, CRUSHED

ULTRABASIC INTRUSIVE

sp	SERPENTINE: LIGHT TO DARK GREEN, SOME TAN OR YELLOW; COMMONLY CRUSHED AND/OR SHEARED, ALTERED.

GEOLOGIC SYMBOLS

?— —?······	GEOLOGIC CONTACT, DASHED WHERE INFERRED, DOTTED WHERE BURIED, QUERIED WHERE DOUBTFUL
35	STRIKE AND DIP OF BEDDING
	GEOLOGIC CONTACT SHOWING DIP
65 35	STRIKE AND DIP OF JOINT
65	SHEAR ZONE SHOWING DIP
	SEEP

EXPLORATION SYMBOLS

AD-5 ⊕	EXPLORATION HOLE
T-20	EXPLORATION TRENCH
TP-19	TEST PIT
SL-1	SEISMIC REFRACTION LINE
7-3 5-2 •	CONCRETE CORE HOLE
8-1 ⑧	FIELD NOTES
E E	GEOLOGIC SECTION

NOTES:

1. GEOLOGIC SECTIONS SHOWN ON FIGURES III-3 TO III-11
2. GEOLOGY AND EXPLORATION OF APPROACH CHANNEL SHOWN ON FIGURE III-1

SCALE

50 0 50 FEET

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SPILLWAY ENLARGEMENT

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GEOLOGY AND EXPLORATION
SPILLWAY CHANNEL

PROJECT NO.	DATE	FIGURE NO.
SCV-124A	NOVEMBER 1983	III-2